Vol. 12, No. 3
February 15, 1987

# Energy Research Abstracts

Abstracts 6393-7867

Office of Scientific & Technical Information
UNITED STATES DEPARTMENT OF ENERGY

# CURRENT INFORMATION ON ENERGY

To provide immediate and complete coverage of literature related to major Department programs, the Office of Scientific and Technical Information provides an on-line retrieval system, data bases, and current-awareness publications. The Energy Data Base (EDB), which contains all unclassified, unlimited energy and nuclear related information processed by OSTI since 1974, and the Nuclear Science Abstracts Data Base (NSA), which covers nuclear information from 1948 through June 1976, are available for machine searching using commercial on-line retrieval systems. All information in the publications listed below, plus additional backup information, is included in the EDB. Current information being added to the EDB is available for on-line searching via the OSTI Automated Retrieval System (OARS) accessible to DOE and contractors through the Integrated Technical Information System (ITIS).

The publications described below and access to ITIS/OARS are available to Department of Energy and contractor components from the Office of Scientific and Technical Information, U. S. Department of Energy, P. O. Box 62, Oak Ridge, TN 37831/Telephone (615) 576-1301; FTS 626-1301.

## PUBLICATIONS OF THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

***Energy Abstracts for Policy Analysis (EAPA)***

A monthly abstract journal devoted to the analysis of energy research, conservation, and policy. Scope and coverage are limited to substantive articles or reports and emphasize legislative, regulatory, and other legal aspects, as well as social, economic, and environmental impacts. *EAPA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price is $72.00 for domestic (North America) or $90.00 for foreign (outside North America) subscribers; a single issue is $5.00 or $6.25, respectively.

***Energy Research Abstracts (ERA)***

A comprehensive semimonthly abstract journal devoted to all areas of energy-related information produced by the Department of Energy, other U. S. government organizations, and foreign governments. *ERA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price for the 24 issues is $146.00 for domestic (North America) subscribers or $182.50 for foreign (outside North America) subscribers. A single issue is $14.00 or $17.50, respectively.

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***Energy Meetings (EM)***

A monthly listing of conferences, symposia, workshops, etc., pertaining to DOE's programmatic interests. *EM* is available on subscription (use PB87-901500) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The annual subscription price is $70.00 for domestic subscribers and $140.00 for subscribers outside the North American continent; a single issue is $8.00 and $16.00, respectively.

The following semimonthly bulletins are also available from the National Technical Information Service. The annual subscription rate for one volume (calendar) year (24 issues; no indexes) is $80.00 for domestic (North America) and $160.00 for foreign (outside North America) subscribers; use the identifying order number (PB- No.) when subscribing.

***Acid Precipitation (APC)***–**PB87-901000.** Acid precipitation, including effects and possible control measures.

***Buildings Energy Technology (BET)***–**PB87-900700.** Technology required for energy conservation in buildings of all types.

***Coal-Based Synfuels (CBS)***–**PB87-901400.** Conversion of coal into gaseous or liquid fuels.

***Coal Combustion and Utilization (CCU)***–**PB87-914400.** Coal combustion, including fluidized bed combustion, and direct utilization of coal for power generation, fuel cells, and MHD generators.

***Coal Preparation and Pollution Control (CPC)***–**PB87-900800.** Coal preparation and cleaning and reducing pollution from its direct combustion.

***Direct Energy Conversion (DEC)***–**PB87-946600.** Photovoltaics, magnetohydrodynamics, electrohydrodynamics, thermoelectrics, thermionics, and fuel cells.

***Energy from Biomass (EFB)***–**PB87-900600.** Biomass production, conversion, and utilization for energy.

***Geothermal Energy Technology (GET)***–**PB87-914700.** Exploration, development, and utilization of geothermal resources.

***Heavy-Ion Reactions (HIR)***–**PB87-900500.** Heavy-ion (A > 4) reactions.

***Laser Research (LAR)***–**PB87-901100.** Laser research and development, excluding applications.

***Nuclear Fuel Cycle (NFC)***–**PB87-913400.** Both front and back ends of the nuclear fuel cycle.

***Nuclear Reactor Safety (NRS)***–**PB87-913500.** Accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures.

***Radioactive Waste Management (RWM)***–**PB87-902900.** Management aspects of transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers.

***Solar Thermal Energy Technology (STT)***–**PB87-901200.** Research and development of efficient and reliable solar thermal conversion systems.

***Transportation Energy Research (TER)***–**PB87-900900.** Energy-efficient advanced automotive propulsion systems and transportation energy conservation.

***Unconventional Petroleum (UCP)***–**PB87-901300.** Secondary and tertiary recovery of petroleum and oil shales and tar sands.

## INTERNATIONAL ENERGY PUBLICATIONS

The Office of Scientific and Technical Information (OSTI) cooperates in the publication of international abstract journals with the following: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts;* and (3) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts.* In each case, the cognizant foreign agency provides the non-U. S. information to OSTI for inclusion in the Energy Data Base; in turn, OSTI provides the U. S. information for input into the respective journal.

***Atomindex***

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from Bernan Associates—UNIPUB, 10033-F King Highway, Lanham, MD 20706. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $355.

***Biomass Abstracts***

A bimonthly abstract journal with comprehensive coverage of information on the conversion of biomass to energy. *Biomass Abstracts* is available free to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 60 IR pounds per year for participating countries and 90 IR pounds per year for nonparticipating countries. Make checks payable to the Institute.

***Coal Abstracts***

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 110 pounds sterling per year.

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# ENERGY RESEARCH ABSTRACTS

## ABOUT THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

The Office of Scientific and Technical Information (OSTI) in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, OSTI places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Although the literature of science is emphasized, coverage extends to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish the mission of furnishing centralized support for Departmental elements in managing their scientific and technical information, OSTI builds and maintains computerized data bases and disseminates information via computerized retrieval systems and announcement publications such as abstract journals, bibliographies, and bulletins. Direct access to OSTI's Energy Data Base (EDB) and Nuclear Science Abstracts Data Base (NSA) is available to the U. S. scientific community through commercial on-line retrieval systems. Access to these data bases from outside the United States is available only through formal exchange agreements. The current-year EDB records, DOE Research-In-Progress, and various other specialized DOE data bases are available to DOE offices and contractors and other government agencies through the OSTI Automated Retrieval System (OARS), which is a major component of the Integrated Technical Information System (ITIS). In addition to providing access to the OSTI on-line systems, ITIS serves as a gateway to other government and commercial systems and provides information merging for customized information products. The Office of Scientific and Technical Information has developed systems to record and communicate energy-related research-in-progress information, to track research report deliverables from DOE contractors, to test and make available DOE-funded computer software programs with scientific and management applications, and to produce special publications in support of DOE program offices. To manage DOE's technical information resources effectively, OSTI's program is one of continual development and evaluation of new information products, systems, and technologies.

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## ABOUT *ENERGY RESEARCH ABSTRACTS*

*Energy Research Abstracts (ERA)* provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

*ERA* is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

*ERA* is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

*ERA* is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $146.00 for domestic subscribers and $182.50 for foreign subscribers. A single issue costs $14.00 (domestic) or $17.50 (foreign). The cumulative indexes will be available in printed form from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, and in microfiche form from the National Technical Information Service, U. S. Department of Commerce, Springfield, VA 22161.

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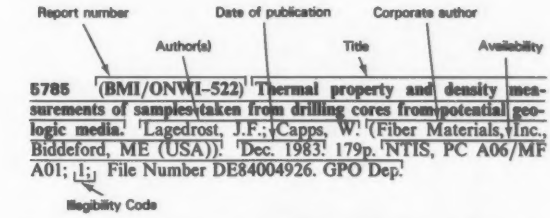
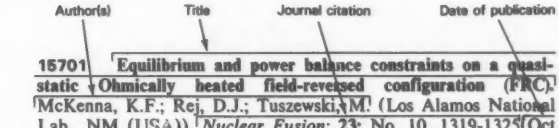
## ABSTRACTS IN *ENERGY RESEARCH ABSTRACTS*

The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.




5785 (BMI/ONWI-522) Thermal property and density measurements of samples taken from drilling cores from potential geologic media. Lagedrost, J.F.; Capps, W. (Fiber Materials, Inc., Biddeford, ME (USA)). Dec. 1983. 179p. NTIS, PC A06/MF A01; 1; File Number DE84004926. GPO Dep.

Abstract: Density, steady-state conductivity, enthalpy, specific heat, heat capacity, thermal diffusivity and linear thermal expansion were measured on 59 materials from core drill samples of several geologic media, including rock salt, basalt, and other associated rocks from 7 potential sites for nuclear waste isolation. The measurements were conducted from or near to room temperature up to 500°C, or to lower temperatures if limited by specimen cracking or fracturing. Ample documentation establishes the reliability of the property measurement methods and the accuracy of the results.




15701 Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC). McKenna, K.F.; Rej, D.J.; Tuszewski, M. (Los Alamos National Lab., NM (USA)). *Nuclear Fusion;* 23: No. 10, 1319-1325 (Oct 1983).

Abstract: Zero-dimensional power balance calculations are performed for a quasi-static, purely Ohmically heated field-reversed configuration. Without compression, the constraint imposed by radial pressure balance limits the power input. Estimates of the energy loss from impurity line radiation as well as from classical and anomalous transport are given. Effects of cold puff gas injection are also investigated.

## INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA).* Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

### ● Corporate Author Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

5785 (BMI/ONWI-522) **Thermal property and density measurements of samples taken from drilling cores from potential geologic media.** Lagedrost, J.F.; Capps, W. **(Fiber Materials, Inc., Biddeford, ME (USA)).** Dec. 1983. 179p. NTIS File Number DE84004926. GPO Dep.

is indexed as:

**Fiber Materials, Inc., Biddeford, ME (USA)**

### ● Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

**Capps, W.,** *See* Lagedrost, J. F.
**Lagedrost, J.F.,** Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
**McKenna, K.F.,** Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;US)
**Rej, D.J.,** *See* McKenna, K.F.
**Tuszewski, M.,** *See* McKenna, K.F.

### ● Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

**SALT DEPOSITS**
**Density**
Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
**REVERSED-FIELD PINCH**
**Energy Balance**
Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;AT)

### ● Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

| | | |
|---|---|---|
| **AC06-76RL01830** | **Fiber Materials, Inc., Biddeford, ME (USA)** | |
| | 9:5785 | BMI/ONWI-522 |

### ● Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under a File Number, that number is included in the availability statement. A file number–report number correlation is included for convenience.

| | | |
|---|---|---|
| **BMI/ONWI-522** | **9:5785** | **NTIS, PC A09/MF A01. File Number DE84004926, Distribution Category MN-70** |

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**Foreign Sources**

CEA Centre d'Etudes de Saclay
GIF-sur Yvette Cedex, France

Fachinformationszentrum
Energie, Physik, Mathematik GmbH
Karlsruhe, Federal Republic of Germany

IEA Biomass Conversion Service
Dublin, Ireland

IEA Coal Research
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Vienna, Austria

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Roskilde, Denmark

Research Center
Netherlands Energy Research Foundation
Petten, Holland

United Kingdom of Great Britain and Northern Ireland
Department of Energy
London, England

**U. S. Sources**

American Institute of Physics
New York, NY

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National Aeronautics and Space Administration
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Communication concerning the editorial policy and content of *Energy Research Abstracts* should be addressed to the Editor, *Energy Research Abstracts,* Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

# SUBJECT CONTENTS (NUMERICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 41 first-level and 276 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope definitions and limitations is available as DOE/TIC-4584-R6 from NTIS for $9.50.


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# ENERGY RESEARCH ABSTRACTS

## 01 COAL AND COAL PRODUCTS

6393 **(DOE/FE—0075) Cooperative R and D ventures an opportunity for leveraged research in fossil energy.** (USDOE Assistant Secretary for Fossil Energy, Washington, DC). Oct 1986. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002349.

A new approach for creating government-industry partnerships to finance fossil fuel research and technology development will be examined in a public meeting to be held by the Department of Energy in Denver on December 3, 1986. In a cooperative venture, the Energy Department would be a minority funding partner, involving itself principally in matters of policy and investment decisions rather than managing detailed technology and business aspects. Other participants, which could include public or private organizations in the same business or industry, would determine the project's scope, technical activities and form of management. Cooperative ventures could include projects involving coal, oil, gas or oil shale. Such research ventures have proven highly productive in the microelectronics and semiconductor fields, and we believe the opportunity may exist to extend this approach into the area of fossil energy research. The Energy Department first proposed the cooperative venture approach in its fiscal 1987 budget request, but Congress indicated that additional details were needed on how cooperative R and D ventures would be applied to fossil energy projects before funds could be specifically appropriated for a cooperative venture pool. The public conference will permit views to be presented that could subsequently be used in structuring the department's participation in cooperative research and development ventures.

### 0104 Processing

*REFER ALSO TO CITATION(S) 6464, 6779*

6394 **(DOE/FE/05081—2196) Engineering support services for the DOE/GRI Coal Gasification Research Program. Quarterly technical status report, March 25-June 24, 1984.** (Foster Wheeler Synfuels Corp., Livingston, NJ (USA)). 1984. Contract AC21-82FE05081. 180p. NTIS, PC A09. File Number DE87001450.

The scope of work under this contract consists of technical assistance in the following areas: advancing the development of coal gasification processes and related technologies to their maximum potential; gathering, compiling, and presenting essential data necessary to delineate the advantages and disadvantages of each competing process; determining and identifying the specific process and/or combination of component processing steps that offer the greatest economic potential for commercial application; performing evaluations to determine the areas of development necessary to provide all technical data, including equipment and material specifications, required for the design and construction of a commercial coal gasification facility; making recommendations and assisting in the compiling of sufficient data to complete conceptual commercial designs and prepare associated factored estimates; evaluating progress reports for consistency, compliance with contract requirements, and adequacy in providing data necessary for process evaluation; and conducting additional studies that could enhance the technical and economic assessment of coal gasification technologies. During the second calendar quarter of 1984, Foster Wheeler continued work on three task assignments which were initiated in 1983; Task No. 1 - monitoring and evaluation of Westinghouse PDU and Cold Flow Scale-up Facility, Mountain Fuels Resources PDU, Bell Aerospace, CNG acid gas removal process, and Metals Properties Council; Task No. 2 - Lurgi Baseline Study; and Task No. 3 - coal fines consolidation study. 8 refs.

6395 **(DOE/FE/60181—2124) Use of treated gasification wastewater in a pilot cooling tower: Final report for the period ending June 30, 1986.** Mayer, G.G.; Johnson, M.D.; Hetland, M.D.; Wentz, C.A. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Sep 1986. Contract FC21-83FE60181. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001012.

To date, six cooling tower tests have been conducted to evaluate the wastewater treatment and reuse process utilized by the Great Plains Gasification Plant (GPGP) facility near Beulah, North Dakota. The first three tests, Phases I, II, and III, were performed using extracted, steam-stripped gas liquor (SGL) produced in the UNDERC pilot-scale slagging fixed-bed gasifier as makeup. The last three tests, Phases IV-A, IV-B and V, were conducted using GPGP produced SGL as makeup. The final test, Phase V, is the subject of this report. Prior to its use as Phase V cooling tower makeup, the GPGP SGL was solvent extracted using the Phenosolvan process to reduce the phenolics level, followed by treatment by the Phosam-W process to reduce ammonia concentrations. Additional pretreatment of the Phase V makeup stream included activated sludge treatment to reduce the organic loading, filtering through diatomaceous earth to remove solids, the use of the Calgon Corporation pHreeGUARD dispersant/corrosion inhibitor system to reduce corrosion and fouling, and the use of Calgon H-510 biocide to control microbial populations within the system. All steps in the pretreatment scheme proved to be effective. Corrosion of carbon steel in the system was held to 2 mils per year (mpy) or less, as measured by weight loss coupons. There was no apparent loss of heat transfer capability or increase in pressure drops in the heat transfer equipment. Fouling was minimal in the Phase V system, although at the end of the testing there was a small amount of biomass present on the cooling tower packing as well as some inorganic fouling in the tower basin. The results of this test indicated that a pretreatment program exists that will allow the successful reuse of SGL as cooling tower makeup. 11 refs., 22 figs., 10 tabs.

6396 **(DOE/FE/60181—2129) Pyrolysis and devolatilization of low-rank coals: Final report, April 11, 1983-June 30, 1986.** Ross, S.F. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Sep 1986. Contract FC21-83FE60181. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001017.

The effects of pyrolysis conditions and coal type on the nature of water-soluble organic effluents have been investigated using a small pyrolysis reactor system and a variety of atmospheres and pressures. The reactor is capable of a maximum heating rate of 45°C/min and a maximum furnace temperature of 1100°C. Variables examined include: (1) particle size, (2) maximum temperature, (3) time at temperature, (4) heating rate, (5) pressure, and (6) effect of atmosphere. Comparisons were made between the yields of water-soluble organic effluents produced from pyrolysis of coal samples under two different atmospheres and those obtained from Great Plains Gasification Plant gas liquor condensate. Results indicated that it may be possible to predict the gas liquor composition of a particular coal in a moving burden or "fixed bed" gasifier, such as a Lurgi dry ash gasifier, system. Four different lithologic layers have been identified in the Freedom Mine which supplies the lignite for the Great Plains Gasification plant in Beulah, North Dakota. The layers were identified on the basis of readily observable megascopic characteristics including luster, fracture characteristics and the presence of clay and silt zones. Lignite sampled from each of the four layers has been pyrolyzed in a bench-scale reactor system designed to simulate the production of gas liquor condensate from the pyrolysis of an actual gasifier. The yields of water-soluble organic effluents from each of the layers were found to differ significantly, particularly the yields of phenol, cresol, and catechol.

Thus, by selective mining and/or blending of coal from different layers, gasifier performance may be improved. 7 refs., 5 figs., 12 tabs.

6397 **(DOE/FE/60181—2165) Comparison of the activated sludge and rotating biological contactor processes for treatment of Great Plains Gasification Plant's stripped gas liquor: Final report for the period ending June 30, 1986.** Mayer, G.G.; Gallagher, J.R.; Shockey, R.E.; Moe, T.A.; Wentz, C.A. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Sep 1986. Contract FC21-83FE60181. 67p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001018.

Fixed film (rotating biological contactor, RBC) and suspended growth (activated sludge) biological treatment processes were used to treat gasification wastewater from the Great Plains Gasification Plant. This report contains the results of the study, including a comparison of the two processes. The wastewater used was a condensate from Lurgi dry-ash gasification of lignite. The condensate was pretreated at Great Plains by solvent extraction and steam stripping to reduce phenols and ammonia, respectively. This pretreated wastewater is known as stripped gas liquor (SGL). At the University of North Dakota Energy Research Center, this wastewater was treated by both methods at the process development unit (PDU) scale. The RBC was a three stage unit that was tested at four organic loadings, ranging from 0.9 to 3.4 lbs BOD/1000 $ft^2$-day. The activated sludge treatment was a completely mixed system with the following operating parameters: a hydraulic retention time of 1 to 4 days, solids retention times of 2 to 13.6 days, and flow rates from 170 to 1500 liters per day (45 to 405 gpd). Process performance data were obtained and the kinetics of treatment were estimated for both treatment units. This report also includes preliminary design data for the RBC and activated sludge processes at the design wastewater flow rate for the Great Plains Gasification Plant. This comparison indicates that for a single process, the activated sludge would probably be the most cost effective. However, the advantages inherent in each process can be realized using the RBC as a pretreatment and the activated sludge process as the polishing step. 22 refs., 36 figs., 17 tabs.

6398 **(DOE/MC/21096—2192) Determination of solid phase boundaries in coal gas desulfurization by zinc ferrite. Final report.** Lamoreaux, R.M.; Britiain, R.D.; Zeiger, J.; Leach, S.C. (SRI International, Menlo Park, CA (USA)). Sep 1986. Contract AC21-84MC21096. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001006.

This report presents results of a study of desulfurization conditions (gas phase composition, temperature, and pressure) needed to prevent the formation of the by-product solid phases wustite, metallic iron, iron carbides, and elemental carbon in the high temperature desulfurization of coal gas by zinc ferrite. Chemical thermodynamic calculations of $Fe_3O_4$ reduction, iron carbide formation, and carbon deposition equilibria were made at incremental values of temperatures from 500° to 700° C and pressures from 1 to 20 atm. Laboratory experiments using solid-gas equilibration and thermogravimetric analysis confirmed the calculated phase boundaries. The phase boundaries were plotted on triangular C-H-O phase diagrams indicating the conditions of temperature, pressure, and gas composition needed to avoid the formation of unwanted solid phases. A computer program was written to interpolate the phase boundaries to intermediate temperatures and pressures. Inert substances such as nitrogen act primarily to dilute the C-H-O components of the gas phase. Zinc loss during desulfurization can be minimized by lowering the temperature, increasing the total gas pressure, and by using less chemically reducing coal gas compositions. 9 refs., 23 figs.

6399 **(DOE/MC/21168—2023) Enhanced sorbent durability for hot coal gas desulfurization: Final report.** Jha, M.C.; Kepworth, M.T.; Baltich, L.K. (AMAX Extractive Research and Development Center, Golden, CO (USA)). Mar 1986. Contract AC21-84MC21168. 196p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86006625.

The objective of this 17-program was to identify and investigate methods that can be used to enhance the durability of zinc ferrite sorbent in removing hydrogen sulfide from hot coal gas, which can then be used in a heat engine or a molten carbonate fuel cell. Zinc ferrite extrudes prepared by United Catalyst Incorporated (UCI) and used in past METC work established the base case against which the enhancement in durability was judged. For the purpose of the present program, the durability was defined as the ability of the sorbent to maintain its desirable physical and chemical properties during long-term cyclic exposure to $H_2S$ containing simulated coal gas in the sulfidation cycle and a mixture of air and steam in the regeneration cycle. The desirable physical characteristics include resistance to disintegration, good crush strength, and high porosity and surface area. The chemical characteristics of importance are the lowest $H_2S$ concentration level in the exit gas that can be attained and the sulfur sorption capacity, both at the breakthrough point and at near saturation, when the $H_2S$ concentration in the exit gas is about the same as in feed gas. The objective was accomplished by investigating over a hundred modifications in the chemical composition of the zinc ferrite sorbent and the agglomeration and induration conditions used in its preparation. Eleven of these new sorbents and two UCI sorbents were studied for their sulfidation and regeneration characteristics in 17 test series, the longest one lasting 92 cycles. AMAX sorbent 1094-49, prepared in the form of spherical pellets using very fine zinc oxide and pigment-grade iron oxide (that contained 88% $Fe_2O_3$, 6% $Mn_3O_4$, and 6% $Al_2O_3$ plus $SiO_2$), was found to be the most durable sorbent. 27 refs., 12 figs., 21 tabs.

6400 **(DOE/METC—86/0242) Coal gasification: Technology status report.** (USDOE Morgantown Energy Technology Center, WV). Aug 1986. 45p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86006624.

The Morgantown Energy Technology Center (METC) of the US Department of Energy (DOE) is currently sponsoring the Surface Coal Gasification Program, which is aimed at developing the full capacity of coal gasification technology to meet the needs of gasification-based systems for future energy requirements. These systems include gas turbines for combined-cycle power generation, new fuel forms production from mild gasification, synthesis gas production, and industrial fuel gas production, as well as fuel cells for the production of power and steam. Gasification projects in the DOE program cover a wide range of scales from laboratory investigations to pilot-plant scale. Fundamental studies of gasification reactions, ash chemistry, transport processes, and modeling are being conducted to uncover potential improvements that may be made to gasification processes. Several pilot plant projects are being sponsored to further promising processing. Fuel gas processing studies may lead to ways of developing an effective, economic process for gas separation and upgrading. Computer models and process simulation techniques are being developed to enhance the capabilities for systems simulations and engineering assessment of existing and advanced processes. These approaches and a description of the projects, along with the major accomplishments in the gasification program, are presented in this technology status report. 57 refs., 26 figs.

6401 (DOE/METC—86/6042, pp 1-14) **Gas stream cleanup program overview.** Moore, W.E. (Dept. of Energy, Washington, DC). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The US Dept. of Energy Office of Fossil Energy's Gas Stream Cleanup Program is developing advanced contaminant control methods for use in hot coal-derived fuel gas streams from direct coal-fired combustors and gasification reactors. The high-temperature, high-pressure (HTHP) cleanup methods being researched provide direct support to Fossil Energy's advanced power conversion systems, including pressurized fluidized-bed combustors, direct coal-fueled turbines (DCFT), integrated gasification combined cycles (IGCC), and molten carbonate fuel cells (MCFC). To ensure system operational capability, the cleanup components must be functional as integrated system elements of the specific coal-fired power conversion system. This overview provides:(1) an estimated cost of electricity (COE) for direct coal-fueled, MCFC, and IGCC power systems using HTHP cleanup system components (these COE projections are made in comparison to a commercial first-generation IGCC Electric Power Research Institute Cool-Water power

plant, and to a pulverized-coal conventional power plant with flue gas desulfurization); (2) an overall status of hot gas cleanup using the IGCC power conversion system with specific emphasis on the Gasifier Island (shop fabricated/modular construction) concept; and (3) an overall programmatic view of the R & D status for each of the contaminant control technology areas of concern: sulfur, particulates, alkali, ammonia, and selected trace metals and residual hydrocarbons.

6402 (DOE/METC—86/6042, pp 15-23) **Simultaneous high temperature removal of alkali and particulates in a pressurized gasification system.** Bachovchin, D.M.; Alvin, M.A. (Westinghouse R & D Center, Pittsburgh, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-83MC20050.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The overall objective of this work is to develop, to a point of readiness for scale up to pilot plant level, a specific concept for removal of alkali metal vapors from hot gases. This concept, which is applicable to gasification and FBC systems, is to pass the gases through a fixed bed of emathlite, a natural clay, with which the alkali reacts irreversibly. The bed material is replaced annually. A commercial process for fabrication of getter pellets, based upon water slurrying and extrusion, was identified processing costs were examined, and pellets were acquired for laboratory testing. The mechanism, stoichiometry, and kinetics of the gettering reaction in laboratory studies, to provide the data for reactor scale-up, was determined. This paper describes tests to determine the capacity of the emathlite for sodium gettering, particularly in the presence of low concentrations of sodium vapor, and demonstrate the concept by testing fixed beds (~ 10 kg) of getter pellets exposed to alkali-laden combustion gases. Results are discussed.

6403 (DOE/METC—86/6042, pp 48-57) **High temperature coal gas chloride cleanup for molten carbonate fuel cell applications.** Krishnan, G.N.; Wood, B.J.; Korens, N.; Anderson, G.L. (SRI International, Menlo Park, CA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21167.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of this program is to study the removal of hydrogen chloride vapor from high temperature coal gas mixtures using natural minerals and synthetic sorbents and to evaluate the technical and economic feasibility of this process for molten carbonate fuel cell (MCFC) applications. The reaction kinetics of three natural minerals and a synthetic sorbent were evaluated thin-bed micro-reactors in the temperature range 535 to 650 C. The efficiency of HCl removal by these materials were also evaluated in bench-scale, deep-bed reactors using simulated coal gas containing HCl vapor and with and without sulfur, tar and trace metal impurities. Laboratory- and bench-scale studies showed that the commercial chloride removal sorbent and sodium carbonate based minerals can reduce the concentration of HCl vapor in hot coal gas to about one ppm level. The natural mineral, nahcolite, possesses a high activity toward HCl vapor and exhibits a high capacity for chloride retention. A preliminary techno-economic analysis for a commercial plant of 100 MW(e) capacity indicated that the annual operating cost of HCl removal process using nahcolite varies from $0.00174 for Texaco oxygen-blown gasifier- to $0.00307 for Lurgi air-blown gasifier-based systems. Cost of the sorbent, although an important variable in operating cost, is minor when compared to capital charges.

6404 (DOE/METC—86/6042, pp 58-77) **Measurement of alkali vapors in PFBC flue gas and their removal with a fixed granular-bed sorber.** Lee, S.H.D.; Myles, K.M. (Argonne National Lab., IL). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objectives of this work are to critically measure the alkali-vapor (Na and K) concentration in pressurized fluidized-bed combustion (PFBC) flue gas on a real-time on-line basis and to demonstrate the fixed granular-bed sorber for the control of alkali vapors from the actual PFBC flue gas. The purposes of the test series completed in this current year are (1) to seek the possible source of the analytical discrepancy between the Ames analyzer and the batch-type alkali and particulate sampling train, and (2) to preliminarily evaluate the performance of the activated bauxite sorber for the control of alkali vapor. Results and accomplishments are summarized. 21 references.

6405 (DOE/METC—86/6042, pp 78-87) **Laboratory evaluation of high-temperature sulfur removal sorbents for direct coal-fired turbines.** Newby, R.A. (Westinghouse R & D Center, Pittsburgh, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-85MC22087.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of this project is to test and evaluate the performance of calcium-based sorbents for sulfur control in direct coal-fired turbines at temperatures up to 1200 C. Two external desulfurization concepts are being considered: coarse-particle fluidized beds and fine-particle entrained beds. The sorbent categories being investigated are untreated limestones, dolomites and dolomitic-limestones; precalcined limestones; and hydrated limes. Both $SO_2$ and $H_2S$ capture are being tested and assessed. All coarse-particle testing has been completed in a pressurized thermogravimetric balance. A pressurized, entrained bed reactor for the fine-particle tests is under construction and will be operated over a similar set of conditions for $SO_2$ and $H_2S$ capture. This report deals only with the coarse-sized sorbent testing and evaluation for $SO_2$ capture.

6406 (DOE/METC—86/6042, pp 88-97) **Performance evaluation of fabric bag filters on a bench-scale coal gasifier.** Chang, R.; Sawyer, J.W.; Lips, H.I. (Acurex Corp., Mountain View, CA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21337.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of the project is to demonstrate the technical and economic feasibility of using high-temperature ceramic filters for particulate control in combined cycle coal gasification power plants. The project consists of three tasks. In Task 1, the performance of a ceramic bag filter was evaluated in a bench-scale fluidized bed gasifier at METC. Performance was primarily measured in terms of collection efficiency, cleanability and durability. In Task 2, the potential of ceramic bag filters for gasifier applications was assessed in laboratory-scale tests under simulated conditions. This task was also used for prescreening filter candidates for the gasifier test in Task 1. In Task 3, a commercial-scale gasifier filter design will be generated using data obtained from the first two tasks and information from literature. This design will be used to estimate the installation and operating costs of a ceramic bag filter system for gasifier applications and provide an evaluation of the technical and economic feasibility of such applications. Results from Task 1 and 2 are described.

6407 (DOE/METC—86/6042, pp 98-112) **Performance evaluation of a ceramic cross flow filter on a bench-scale coal gasifier.** Lippert, T.E.; Meyer, J.H. (Westinghouse Electric Corp., Pittsburgh, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21338.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The current DOE cross flow filter development program being carried out by Westinghouse is intended to obtain information on the operational and economic feasibility of applying the cross flow filter to coal gasification power generating systems. The program calls for three general areas of effort to reach these goals. The first area of work is to conduct a small, bench-scale test program at METC where the cross flow filter was operated in an actual gasification system. This relatively short duration test program was intended to offer proof of concept in the application rather than a detailed data base of operating experience. The second area of effort involves experimental and theoretical efforts aimed at the development of design principles and data that are thought to be lacking, but needed for scale-up calculations. For the

cross flow filter this task primarily deals with the development of sound methods for scaling up the blowback system from single element data to the multielement designs. The third area of effort is to be directed at using scale-up algorithms to arrive at conceptual designs and costs for full size filter systems for various gasification technologies.

6409 (DOE/METC—86/6042, pp 113-122) **Performance evaluation of an electrostatic precipitator on a bench-scale coal gasifier.** Rugg, D.; Durham, M.; Armstrong, J. (Denver Research Institute, CO). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21092.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The program is to evaluate electrostatic precipitator performance on actual fuel gas from a bench-scale high temperature high pressure coal gasifier. In addition, alternate ESP design principles have been evaluated during a limited test program. The results of these two evaluations will be used to perform technical and economic analyses of the feasibility of successfully operating an ESP as the primary cleanup device for a combined cycle gasifier system. After a brief description of the ESP, results o tests on the variable capacitance vibration transducer, designed to measure the acceleration, velocity, and displacement of the collector surface, are discussed. The rapping measurement tests are also described.

6408 (DOE/METC—86/6042, pp 123-133) **Low turbulence/high efficiency cyclone separators.** Paul, D.; Razgaitis, R.; Jordan, H.; Faulkner, L.; Andrus, P.; Brodkey, R.; Munson-McGee, M. (Battelle Columbus Labs., OH). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-83MC20108.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of this work is to improve the collection efficiency of industrial-sized cyclone separators by inhibiting fine particle reentrainment through the use of turbulence suppression techniques. This work has been carried out in three separate facilities: (1) The Cyclonic Wind Tunnel (CWT) facility, (2) The Curvilinear Boundary Layer (CBL) facility, and (3) The Baseline Cyclone Facility (BCF). The purpose of the CWT facility is to provide a highly reproducible swirling flow field which can be used to judge the performance of various turbulence suppression concepts. A Laser Doppler velocimeter (LDV) system is used to measure the turbulence parameters of the flow field. The purpose of the CBL apparatus is to provide flow visualization of the coherent structures present in the cyclonic flow field both with and without the turbulence suppression concepts installed. The CBL uses water as the working fluid in order to provide a thick, visually-observable boundary layer. Slow-motion of neutral density spheres in the wall region of the cyclonic flow field have been taken. The purpose of the third facility, the BCF, is to provide proof-of-principle tests for the most promising concepts tested in either the CWT or CBL facility. The BCF consists of a three-foot diameter cyclone separator which can be modified to incorporate the various turbulence suppression concepts. A description of the experimental apparatus and a summary of results to date are given for each facility.

6410 (DOE/METC—86/6042, pp 134-144) **Development of acoustic agglomerator.** Faeser, R.; Reethof, G. (Aerojet Energy Conversion Co., Rancho Cordova, CA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC20107.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The Aerojet Energy Conversion Company is conducting a program to develop a particulate removal system based on acoustic agglomeration that is suitable for cleaning the products of coal combustion from PFBC. Aerojet is developing combustion driven sound source, performing system analysis and design, optimization and economic analysis in addition to being prime contractor. Pennsylvania State University's Noise Control Laboratory is a team member developing air, siren sound source, high temperature, high pressure agglomeration facility and acoustic agglomeration analysis. The following paragraphs briefly describe the background, project description, accomplishments to date, and the future plans.

6411 (DOE/METC—86/6042, pp 145-153) **Performance evaluation of a cross flow filter on a subpilot-scale pressurized fluid bed coal combustor.** Lippert, T.E.; Smeltzer, E.; Meyer, J.H. (Westinghouse Electric Corp., Pittsburgh, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-85MC22136.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of this program is to evaluate the performance and operating characteristics of the cross flow filter on a coal fired, pressurized, fluidized bed combustor (PFBC). This data will also be used to evaluate the economic feasibility of the cross flow filter concept in a PFBC system. The tests will be carried out utilizing the existing New York University subpilot scale PFBC. The filter unit will be a multielement configuration that will be operated for about 200 hours at conditions to demonstrate particle removal capability to levels required for meeting power plant New Source Performance Standards (NSPS) and/or economic plant operation. The work carried out to date has centered on the design, fabrication and delivery of the test unit to be installed at NYU. This work has included efforts to use and modify an existing DOE owned pressure vessel and internals, the design and fabrication of cross flow filter mounting hardware, the specification of an instrument and control system, the development of a pulse jet cleaning system and the actual fabrication of the larger cross flow filters to be tested. The filter vessel, internals, and instrumentation are described.

6412 (DOE/METC—86/6042, pp 154-164) **Performance evaluation of a screenless (counter-current) granular bed filter on a subpilot-scale PFBC.** Wilson, C.; Cooper, J.; Placer, F. (Combustion Power Co., Menlo Park, CA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The US Dept. of Energy is currently sponsoring programs to develop coal-fired, pressurized fluidized-bed combustors (PFBC's) to be used in combined-cycle, power generating systems. Combustion Power Company (CPC) has been funded to fabricate a Granular Bed Filter (GBF) hot gas cleanup of the combustion gases. It will be operated on a pilot-plant-scale PFBC at New York University, Westbury, New York in late 1986. The objectives of this investigation are: (1) to augment information on the feasibility of a GBF for controlling particulate in a PFBC power generating system, (2) to assess the design and life of critical components in the filter system, and (3) to estimate costs of a commercial-scale design based on tested concepts. This paper describes the equipment that will be tested.

6413 (DOE/METC—86/6042, pp 165-175) **Sub-pilot scale high-temperature high pressure precipitator testing at NYU facility.** Kumar, K.S.; Feldman, P.L. (Cottrell Environmental Sciences, Somerville, NJ). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21094.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The cleanup of particulate emissions from pressurized fluidized-bed combustor (PFBC) exhaust gas is one of the most important technical barriers to the commercialization of PFBC systems. The Dept. of Energy has sponsored research programs in advanced hot gas cleanup technology over the past several years to develop efficient and reliable particulate control systems ahead of the gas turbine. The development of these systems is geared to simultaneously meet the environmental and turbine wear protection criteria. The electrostatic precipitator is one of the technologies chosen by the DOE for high efficiency particulate control at the PFBC exhaust conditions of 1650 F and 10 atmospheres. The electrostatic precipitator has been designed and installed at the New York University's sub-pilot PFBC facility located at Westbury, Long Island. This horizontal flow precipitator will be suitable for gathering applications data for estimating its commercial feasibility and is now ready for testing.

6414 (DOE/METC—86/6042, pp 190-212) **Analysis of fuel gas cleanup for molten carbonate fuel cells. The effect of temperature and pressure on the regeneration of zinc ferrite desulfurization sorbents.** Grindley, T. Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The overall project objective is to demonstrate, at a small scale, the ability of zinc oxide-containing sorbents (and/or other novel sorbents) to remove sulfur compounds from hot coal gas to a level specified for molten carbonate fuel cells (~ 1 ppm) and gas turbines (~ 10 ppm), and to be regenerated for cyclic use. In the past year the principal objective has been to evaluate the regenerability of a zinc ferrite sorbent (a) after sulfidation with simulated low-Btu gas in a 2-inch diameter, lab-scale, fixed-bed reactor and (b) after sulfidation in a sidestream of low-Btu gas, from a fluid-bed gasifier, in a 6-inch diameter fixed-bed reactor. In bother cases, regeneration was with a steam/air mixture. Parameters to be investigated were regeneration and reaction zone temperatures at the lab scale, with the additional parameter of regenerant preasure at the sidestream scale. The lab-scale and gasifier sidestream experiments have demonstrated that zinc ferrite coal gas desulfurization sorbents can be regenerated through three cycles with steam/air mixtures at temperatures from 204 to 538 C and at pressures from 0 to 1725 kPa (250 psig) without significant loss of absorptive power. However, low-temperature and high-pressure regeneration results in a greater amount of residual sulfate in the regenerated sorbent. This residual sulfate is rapidly decomposed when the regenerated sorbent is exposed to the hot coal gas and the sorbent porosity, which is decreased by the presence of sulfate, is largely restored to the porosity of fresh sorbent.

6415 (DOE/METC—86/6042, pp 213-220) **Solid phase boundaries in coal gas desulfurization by zinc ferrite.** Lamoreaux, R.H.; Brittain, R.D.; Hildenbrand, D.L. (SRI International, Menlo Park, CA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21096.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The program objective was to provide chemical information needed to avoid forming wustite, iron, cementite, and carbon solid phases during desulfurization of coal gas with zinc ferrite. Specific goals were to calculate the stability limits for solid phases in equilibrium with the gas phase, to show these limits on isothermal diagrams of C-H-O gas phase compositions, and to perform laboratory experiments checking the calculations. The program consisted of five tasks: literature survey; program plan and design of experiments; chemical thermodynamic analysis; laboratory experiments; and data analysis. Each has been completed and methods and results are reviewed.

6416 (DOE/METC—86/6042, pp 221-230) **Structural changes in metal oxide hot coal gas desulfurization sorbents.** Ranade, P.V.; Focht, G.D.; Sa, L.N. (Louisiana State Univ., Baton Rouge). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

A single particle electrobalance reactor is being used to measure the global kinetics of the sulfidation/regeneration reactions of hydrogen sulfide and zinc ferrite as a function of gas composition and temperature. Multiple cycle tests involving as many as four sulfidations and regenerations of a single pellet have been completed. The sulfidation reaction has been studied over a temperature range of 500-700 C using 0.6 to 3.0 mole percent hydrogen sulfide. The composition of the remaining gas was chosen to simulate a water-quenched oxygen-blown gasifier product. Regeneration has been studied over a temperature range of 550-850 C in an atmosphere of oxygen, steam, and nitrogen. Supplementing the single-particle kinetic measurements, the structural properties (specific surface area, pore volume, and pore size distribution) of the solid reactant and products have been measured. In addition, the radial distribution of sulfur in partially sulfided and partially regenerated samples has been determined using SEM-EDAX. The paper describes results from the first cycle regeneration experiments and from multiple sulfidation/regeneration cycles.

6417 (DOE/METC—86/6042, pp 231-243) **Enhanced sorbent durability for hot coal-gas desulfurization.** Hepworth, M.T.; Smith, W.E.; Doane, R.E.; Baltich, L.K. (AMAX Extractive Research and Development Center, Golden, CO). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21168.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The prime objective of this program was to identify and investigate methods for enhancing the durability of zinc ferrite type sorbents. The methods included modification of chemical composition and agglomeration and induration procedures. The methods had to be adaptable for commercial scale production of the sorbent. The other objectives of the program were to: perform sulfidation and regeneration tests on selected sorbent samples for up to 100 cycles; analyze the test data and categorize the sorbents in order to select the best sorbent and to evaluate the effect of various process parameters on the durability of the sorbent; and produce one cubic foot of the best sorbent for possible future testing at METC. The following main conclusions were reached. (1) Catalyst- or pigment-grade iron oxide made a better sorbent. (2) The presence of manganese oxide might have been advantageous. (3) Stoichiometric excess of zinc was harmful. (4) A bentonite type binder gave a strong stable structure. (5) An organic binder might help produce a porous structure. (6) Modifiers might help enhance diffusivity and reactivity. (7) Spherical pellets were easy to produce and packed better. The combination of several of these features constitutes a novel process for producing durable sorbents. A patent application has been filed.

6418 (DOE/METC—86/6042, pp 244-256) **Development of a hot gas cleanup system.** Anderson, G.L.; Berry, F.O.; Shah, R. (Institute of Gas Technology, Chicago, IL). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-85MC22144.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

For a number of years, IGT has been exploring means for removing deleterious chemical contaminants from hot coal-derived fuel gases. One concept that IGT has been exploring with DOE support is an innovative high-temperature fuel gas desulfurization process that IGT has named the mixed metal oxide process. In this process, sulfur-containing compounds ($H_2S$, COS) are removed from a hot fuel gas by reaction with a mixture of metal oxide-containing sorbents. The current hot gas cleanup program at IGT has five principal tasks. In addition to laboratory-scale studies to optimize the cobalt titanate-containing sorbent used in the mixed metal oxide process, and laboratory-scale studies on alternative less costly molten carbonate-containing sorbents for hot HCl removal, this program includes the design and construction of a new 3000 SCF/h skid-mounted bench-scale hot gas cleanup test unit. This unit will be in integrated with a 6-inch fluidized-bed gasifier at IGT, and promising hot gas cleanup sorbents will be tested. At the conclusion of testing, cost studies on the tested description of each task and results to date are given.

6419 (DOE/METC—86/6042, pp 257-266) **Detailed studies of novel regenerable sorbents for high-temperature coal-gas desulfurization.** Flytzani-Stephanopoulos, M.; Jothimurugesan, K.; Gavalas, G.R.; Sharma, P.K. (Massachusetts Institute of Technology, Cambridge). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract FC21-85MC22193.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The main objectives of this contract are to: (1) investigate the effects of additives such as $Al_2O_3$ or $TiO_2$ on the high-temperature chemical stabilization of active sorbent oxides (e.g., ZnO, CuO) against reduction to metallic state (during sulfidation) or irreversible solid phase segregation (either during sulfidation or regeneration). Optimize sorbent composition for regenerative, high-per-

formance operation over the temperature range of 1000-1500 F. (2) Prepare sorbents in pelletized or other form such that desired physical properties (pore size, porosity, etc.) of sorbents with composition as determined above are preserved. Determine the mechanical stability of the selected sorbent(s) in extended cyclic operation using lab-scale test equipment. (3) Carry out parametric regeneration studies of the selected sorbent(s) aiming both at complete sorbent regeneration as well as concentrated sulfur products ($SO_2$ or elemental sulfur) in the regeneration off-gas. Several new compositions of Cu-Fe-Al-O mixed oxides have been prepared, characterized, and evaluated in sulfidation/regeneration tests. Results of these tests, as well as test of ZnO-containing sorbents, are discussed.

6420 (DOE/METC—86/6042, pp 267-279) **Potential benefits of improved mass transfer in SSMS hot gas cleanup.** Lyke, S.E.; Butner, R.S.; Roberts, G.L. (Pacific Northwest Lab., Richland, WA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The SSMS process offers the advantages of one step $H_2S$, COS and HCl removal, a physically stable sorbent and recovery of elemental sulfur but appears more expensive than alternate means of gas cleanup. The current project is using modeling, a modest experimental effort and engineering analysis to establish the potential for developing a cost-effective process. Because both mass transfer and equilibrium are limiting, temperature, pressure, gas composition and space velocity all influence performance of an SSMS absorber in significant and complex ways. Previous work had shown these effects to be predictable by a relatively simple mass transfer model combined with experimental equilibrium data. The current modeling effort is to develop a BASIC computer language program that will allow designers to predict the behavior of $H_2S$, COS, HCl and metal chloride vapor through multiple cycles of absorption and regeneration. The model was confirmed by comparison with an analytical solution for a simplified case and will be tuned to fit previously obtained and new experimental data. The experimental program is directed toward testing two improvements suggested by analysis of previous work. The first is to develop a lower cost, higher surface area sorbent and the second is to demonstrate pressure swing regeneration. Modeling suggests that increasing surface area should yield significant performance improvements and engineering analysis shows that increasing pressure for regeneration rather than decreasing temperature should further reduce processing costs. Results of the modeling and experimental efforts will be combined in an engineering analysis task. An HCl recovery scheme will be compared with sorbent replacement or a separate HCl removal step. Preliminary modeling results and sorbent preparation progress are described.

6421 (DOE/METC—86/6042, pp 280-292) **Process systems and economic studies for high temperature desulfurization processes.** Klett, M.G.; Boulay, R.B.; Buchanan, T.L.; Chen, H.T. (Gilbert/Commonwealth, Inc., Reading, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21098.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The purpose of this study was to provide conceptual commercial-scale designs, including engineering, cost and economic information for high temperature desulfurization processes. The commercial-scale processes were designed as an integral part of a nominal 100 MW(e) power plant. Two types of power plants were considered, a coal gasification molten carbonate fuel cell (MFCF) power plant and an integrated gasification combined cycle (IGCC) power plant. The paper presents the results of the conceptual designs and cost estimates for the high temperature desulfurization processes integrated with an MCFC. Work is now in progress for the IGCC portion of the study. Three desulfurization processes (zinc ferrite, solid-supported molten salt, and mixed metal oxides) combined with four different gasification processes (air, fixed bed, dry ash; O2, Texaco, quench; O2, KRW, fluid bed; and O2, fixed bed, dry ash) were evaluated, for a total of eleven cases for each power plant. In addition, for each zinc ferrite case, two sulfur recovery options were investigated, flue gas scrubbing and the production of elemental sulfur.

6422 (DOE/METC—86/6042, pp 293-300) **Chemical cleanup systems analysis.** Craig, K.R.; Regenhardt, P.A.; Koch, R.W. (METC Systems Technology and Support Div., Morgantown, WV). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of this project is to provide computer-based systems analysis expertise to assess the system implications of both near term and advanced high temperature, high pressure (HTHP) processes for removal of sulfur, nitrogen, alkali, and other contaminants on the overall performance of coal-based systems. The systems of current interest include coal gasification systems which utilize gas turbines for power generation. The accomplishments to date, discussed within this paper are: (1) development of systems level absorption and regeneration models for the zinc ferrite process using the ASPEN process simulator; (2) development of preliminary systems models for the RESOX and Wellman-Lord tail gas treatment processes; (3) investigation of the potential environmental aspects of spent sorbent disposal and the possible effect on a process using this treatment method; (4) investigation of the impact of the zinc ferrite and/or RESOX processes on various gasification island/gas turbine systems; and (5) investigation of the consequences of recycling regeneration tail gas from a zinc ferrite unit to the gasifier.

6423 (DOE/METC—86/6042, pp 301-313) **Applications of organo-calcium chemistry to control of contaminant aromatic hydrocarbons in advanced coal gasification processes.** Longwell, J.P.; Peters, W.A. (Massachusetts Institute of Technology, Cambridge). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The overall goal is to provide quantitative understanding of the thermal reactions of aromatic contaminants - with emphasis on freshly formed coal pyrolysis tars and benzene - with calcium oxide under conditions pertinent to in situ, or outboard reduction or elimination of these contaminants from advanced coal gasification process and waste streams. Specific objectives are to: study the cracking of fresh coal pyrolysis tar over CaO; study benzene cracking over CaO; determine CaO deactivation behavior; and perform a preliminary assessment of process economic implications. The results to date are discussed for the first and second objective.

6424 (DOE/METC—86/6042, pp 314-324) **Catalytic tar conversion in coal gasification systems.** Baker, E.G. (Battelle Northwest Lab., Richland, WA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of this study was to evaluate catalysts for removal or conversion of tar in hot coal gas streams. The envisioned catalytic system would operate in conjunction with the hot gas desulfurization processes. Ideally the tar would be converted to a gas product which would recover the heating value of the tar in the gas stream. Sulfur compounds in the tar would be converted to $H_2S$ or COS which could be removed by the hot gas desulfurization processes. The effects of process conditions on the performance of the selected catalysts and the mechanism of tar cracking are discussed. 16 references.

6425 (DOE/METC—86/6042, pp 325-333) **Catalytic cracking of aromatic hydrocarbons.** Simons, G.A.; Ham, D.O.; Moniz, G. (Physical Sciences Inc., Andover, MA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21385.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

Product gases from coal gasification contain heavy hydrocarbons, mainly aromatic hydrocarbons (AHD), which can reach concentrations as high as 8000 ppm from fixed-bed gasifiers. The costs for removing AHC's from gasifier effluent can be decreased by replacing cleanup devices, such as scrubbers or absorbers, by

catalytic cracking in the reaction zone of the gasifier or in a subsequent cleanup bed. This study investigated cheap, disposable materials for use as cracking catalysts to eliminate AHC's. Previous studies have concluded that iron in a reduced state is the most effective catalyst for AHC destruction. The objective of this program was to screen all six of the iron containing minerals identified in the mineralogical analysis of coals reported in the Penn State Coal Data Base: siderite, ankerite, hematite, magnetite, pyrite, and jarosite. Samples of each of these minerals were exposed to a simulated coal gas ($N_2$, CO, $CH_4$, $CO_2$, $H_2$, and $H_2O$) in the PSI high temperature fixed-bed reactor. The resulting pore structure was characterized with mercury porosimetry as well as helium and nitrogen density measurements. These data were obtained to assess the role of inter-particle transport in reducing the reactivity data. The data reduction has suggested that the intraparticle transport is not rate controlling. The thermochemistry of the iron reduction and the possible time-temperature dependence of the sintering of the internal surface area appear to control the reactivity. Since benzene is the most difficult AHC to crack, it was used as a model species in the cracking tests. Results are discussed.

6426 (DOE/METC—86/6042, pp 354-359) **CNG acid gas removal process.** Brown, W.R.; Lui, Y. (CNG Research Co., Pittsburgh, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-83MC20230.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

CNG Research Company has conceived and is developing a new acid gas removal process to remove sulfur compounds, residual trace contaminants, and carbon dioxide from gas mixtures at moderately low temperature. The process is especially suited for medium to high pressure (300 to 1000 psia gas streams containing substantial amounts of carbon dioxide). The objectives of this study are to (1) design, construct, and operate a CNG process demonstration unit; (2) demonstrate absorption of sulfur compounds with liquid carbon dioxide, and regeneration of clean carbon dioxide by triple point crystallization; and (3) develop a triple-point crystallizer computer model. A process overview is presented and results on all three tasks are discussed.

6427 (DOE/METC—86/6042, pp 360-364) **$H_2S$ removal from gasified coal.** Lynn, S. (Lawrence Berkeley Lab., CA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC03-76SF00098.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The UCB Sulfur Recovery Process (UCBSRP) is a general method for removing $H_2S$ from gases. The UCBSRP consists of: absorbing the $H_2S$ in a polar organic solvent; converting the dissolved $H_2S$ to sulfur by reacting it with an equivalent amount of $SO_2$ dissolved in the same solvent; recovering elemental sulfur from the solvent by crystallization; recovering co-absorbed gases from the solvent by stripping; and generating the $SO_2$ for the process by burning $H_2S$ or sulfur (while generating steam) and absorbing the $SO_2$ with cooled solvent. The objective of this study is to: determine the solubilities of $H_2S$, $SO_2$, $CO_2$, methane and other hydrocarbon gases, water and sulfur in the organic solvent as functions of pressure, temperature, and solvent composition; determine the effects of temperature and solvent composition on reaction kinetics; investigate the suitability of steel and other materials of construction for this system; determine the parameters controlling the crystal size distribution of the sulfur that will be formed in the process; determine the parameters controlling reactive absorption of $H_2S$ by solutions containing $SO_2$; set up a computer model of this process to aid in its evaluation and evolution; and compare the anticipated costs of this process with those of conventional technology. The results to date on gas solubilities are reported. Other results are briefly reviewed.

6428 (DOE/METC—86/6042, pp 365-369) **$SO_2$ adsorption on Silicalite molecular sieve.** Chriswell, C.D. (Ames Lab., IA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract W-7405-ENG-82.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objectives of this project are to demonstrate the technical feasibility of removal of sulfur dioxide from combustion gases by absorption on Silicalite molecular sieve, to elucidate the effects of experimental parameters on the effectiveness of removal and recovery of sulfur dioxide and the potential recovery of sulfur trioxide, and to determine if the overall process is economically feasible. The paper describes the properties of silicalite and the present work directed toward obtaining precise data on the absorption of $SO_2$ from gas streams under conditions that can be related to actual desulfurization plants. No results are reported.

6429 (DOE/PC/50003—23) **Enhanced catalysis by solvent improvement. Quarterly technical progress report, 1 July-30 September 1983.** Garg, D.; Miller, R.N.; Givens, E.N.; Tarrer, A.R.; Guin, J.A.; Curtis, C.W. (Air Products and Chemicals, Inc., Allentown, PA (USA); Auburn Univ., AL (USA)). Feb 1984. Contract AC22-82PC50003. 34p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87001919.

This report describes the results from liquefaction solvent modification, coal liquefaction with modified solvent, catalyst selection, coal pretreatment, and pretreatment followed by liquefaction experiments. Treatment of base liquefaction solvent with various clays/solid adsorbents such as bentonite, kaolin, and porocel resulted in almost no removal of both nitrogen and oxygen compounds. Catalytic liquefaction of Illinois Number 6 coal in the presence of base liquefaction solvent treated with acidic alumina to remove oxygen compounds showed a marginal increase in the oil production. However, oil production increased significantly with additional removal of phenols from the base liquefaction solvent as noted with the use of solvent treated with basic alumina. The catalytic activity of 1 wt % iron impregnated into coal was noted to be similar to that of 500 ppM molybdenum when modified solvent generated by treating base liquefaction solvent with anhydrous HCl followed by silica gel was used as liquefaction solvent. Air oxidation of Illinois Number 6 Burning Star coal under the conditions corresponding to about <3% oxygen uptake did not seriously affect the liquefaction product distribution, provided modified solvent was used in the liquefaction. However, more severe oxidation corresponding to oxygen uptake in excess of 3% was clearly detrimental to coal conversion and oil production regardless of whether modified solvent was used. Mild air oxidation of Illinois Number 6 produced only a minor fraction of metal adsorption sites relative to the large amount of oxygen incorporated. Hence, ion-exchange treatment of oxidized coal with iron sulfate did not produce a significant increase in the oil yield over that found for iron sulfate treatment of original coal. 8 refs., 1 fig., 11 tabs.

6430 (DOE/PC/50003—24) **Enhanced catalysis by solvent improvement. Quarterly technical progress report, 1 October-31 December 1983.** Miller, R.N.; Garg, D.; Givens, E.N. (Air Products and Chemicals, Inc., Allentown, PA (USA)). Feb 1984. Contract AC22-82PC50003. 37p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87001643.

This report describes the results from coal pretreatment and pretreatment followed by liquefaction experiments. The coal pretreatment techniques discussed in this report include grinding of Illinois Number 6 coal in the presence of inert gas, air, alcohol, base liquefaction solvent, modified solvent, and toluene. The use of base liquefaction solvent to grind coal prior to liquefaction was markedly detrimental to oil production. However, grinding coal in the presence of modified solvent prior to liquefaction showed marginally higher oil production than that noted with liquefaction of coal pre-ground in helium. The use of elevated temperatures during grinding of coal in the presence of any liquefaction solvent showed insignificant improvement in oil yields over that noted at low temperatures. Grinding coal in air was quite detrimental to oil yield when liquefaction was performed in the presence of base liquefaction solvent. On the contrary, liquefaction of air ground coal with modified solvent showed significantly higher oil yield compared to liquefaction in the presence of base liquefaction solvent. Grinding of coal in the presence of ethyl alcohol as well as extraction of coal with alcohol prior to liquefaction in the presence of either base liquefaction solvent or modified solvent was quite detrimental to both oil production and coal conversion. Finally, the use of toluene to grind coal in the presence of molybdenum hexacarbonyl resulted in

significantly higher oil production upon liquefaction using modified solvent compared to the oil yield obtained by grinding coal in modified solvent containing either oil-soluble molybdenum catalyst or molybdenum added as molybdenum hexacarbonyl. 3 refs., 6 figs., 10 tabs.

6431 **(DOE/PC/50003—33) Enhanced catalysis by solvent improvement. Quarterly technical progress report, 1 April-30 June 1984.** Garg, D. (Air Products and Chemicals, Inc., Allentown, PA (USA)). Oct 1984. Contract AC22-82PC50003. 26p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87002275.

This report describes the results obtained by liquefying Illinois Number 6 coal with hydrotreater and modified hydrotreater solvents, both in the presence and absence of a catalyst. This report also describes the results obtained by recycling SRC using base liquefaction and modified solvents, both in the presence and absence of molybdenum catalyst. The use of a hydrotreater solvent as solvent in noncatalytic coal liquefaction resulted in significantly higher oil yield and coal conversion compared with both base liquefaction and modified solvents. The higher yields were thought to be due to (1) higher hydrogen content of the hydrotreater solvent resulting in higher hydrogen donor capability, and 2) lower concentration of heteroatomic compounds in the hydrotreater solvent than both base liquefaction and modified solvents, resulting in higher autocatalytic activity of the mineral matter in the coal. Removal of a part of the heteroatomic compounds from the hydrotreater solvent resulted in no noticeable improvements in coal liquefaction compared with untreated hydrotreater solvent. Similarly, addition of molybdenum catalysts in the presence of hydrotreater solvent showed only marginal improvements over the noncatalytic run. This result was unexpected because significant improvement in liquefaction with catalysts had always occurred. However, addition of molybdenum catalyst with modified hydrotreater solvent caused a noticeable improvement in both oil yield and conversion. These results infer that solvent properties are more important in coal liquefaction than is the catalyst. Recycling of SRC in noncatalytic liquefaction significantly increased oil yield with both base liquefaction and modified solvents. However, coal conversion decreased considerably with SRC recycle. Recycling SRC in catalytic coal liquefaction significantly increased oil yield with both base liquefaction and modified solvents. 3 refs., 2 figs., 8 tabs.

6432 **(DOE/PC/70774—T4) Characterization of Alaskan coals: evaluation of their liquefaction behavior. Final technical progress report, July 1984-February 1986.** Youtcheff, J.S.; Rao, P.D. (Alaska Univ., Fairbanks (USA). Mineral Industry Research Lab.). 1986. Contract FG22-84PC70774. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86016120.

Nineteen coals, representing seven of Alaska's coal fields, were liquefied in batch reactors at 425°C with tetralin as the donor solvent. The lignite and subbituminous coals from Little Tonzona, Nenana, Beluga and Yukon Flats coal fields were found to readily convert to THF solubles plus gases. Conversions for these coals were greater than 84% (daf basis). The bituminous coal from the Matanuska coal field and the inertinite-rich coals from the Northern Alaska and Chicago Creek coal fields were considerably less reactive; conversion yields from 55 to 82% were attained. A number of correlations were examined between conversion yield and coal characteristics. Evaluation of the distribution of liquefaction products showed that the low rank coals are readily converted into low molecular weight components (oils plus gases) and few asphaltenes and preasphaltenes. The inertinite rich and other less reactive coals produced equal distributions of the three product classes. The coals and hexane-insolubles were analyzed using DRIFT spectroscopy. The spectrum of HZA was found to be similar to that of a guaiacyl-type lignin. Changes in the spectral features as a function of liquefaction severity were examined. Preliminary studies were conducted to enhance an understanding of fluorescent vitrinite, inertinite macerals and the role of cations during liquefaction. The primary fluorescence exhibited by the ulminite in the HZA coal appears to be attributed to the presence of substituted aromatics. Some of the inertinites in UA-139 were determined to be reactive. The presence of cations was found to enhance the conversion of UCM-11 and CSB-13, presumably by diminishing the tendency for condensation reactions to occur. 34 refs., 21 figs., 9 tabs.

6433 **(DOE/PC/70797—T3) Fundamental approach to characterization and processing of coal-derived-liquid (CDL). Fourth quarterly report, June-August 1985.** Bunger, J.W. (Utah Univ., Salt Lake City (USA). Dept. of Fuels Engineering). 13 Sep 1985. Contract FG22-84PC70797. 11p. D; 2; GPO Dep. File Number DE87001947.

Loss of catalytic activity during hydroprocessing of coal derived liquid continues to be an important technical problem requiring research attention. We have postulated that competitive adsorption plays a significant role in reduced catalytic activity. In the third quarterly report, we have reported a technique to determine the enthalpy and entropy of adsorption on a catalyst surface. Also, some above mentioned parameters for simple aromatic substrates were reported. This report covers the analysis of normal paraffins in a mixture and in two groups of mixtures. The current work with paraffins is being conducted to ascertain factors influencing adsorption such as catalyst surface changes, gas composition, and sulfiding effects. The heat of adsorption and entropy of adsorption for normal paraffins ($n\text{-}C_6H_{12}$ to $nC_{16}H_{34}$) are summarized in Table 1 and are shown to decrease with an increase in molecular weight and with heat of vaporization, which indicates a favorable adsorption on catalyst surface. A computer program was developed to fit these experimental data. 1 ref., 6 figs., 1 tab.

6434 **(DOE/PC/70797—T6) Fundamental approach to characterization and processing of coal-derived-liquid (CDL). Seventh quarterly report, March-May 1986.** Bunger, J.W. (Utah Univ., Salt Lake City (USA). Dept. of Fuels Engineering). 2 Jul 1986. Contract FG22-84PC70797. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001950.

Adsorption thermodynamic properties of nearly fifty model compounds have been measured. Data have been used to develop a model to predict adsorption equilibrium based on molecular structure of the adsorbing species. Molecular weight has a major influence on both heat of adsorption and entropy of adsorption values. Additional contributions are observed from aromatic rings and polar (hydrogen bonding) functionalities. The model has been used to predict the adsorption of three fractions distilled from SRC-II coal-derived-liquid (CDL). Theoretical considerations of the steady state composition of surface adsorbed species in a flow system reveal that with a broad boiling range material only the heaviest portion is adsorbed on the catalyst. These findings have major implications to catalytic processing of CDL. The results of the adsorption measurements and from the theoretical considerations will be related to kinetics derived from catalytic hydroprocessing of the distillates. 11 figs, 6 tabs.

6435 **(DOE/PC/70797—T7) Fundamental approach to characterization and processing of coal-derived liquid (CDL). Eighth quarterly report, June-August 1986.** Bunger, J.W. (Utah Univ., Salt Lake City (USA). Dept. of Fuels Engineering). 10 Oct 1986. Contract FG22-84PC70797. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001951.

A sample of SRC-II coal-derived-liquid (CDL) was fractionated into three boiling ranges (230 to 275; 275 to 325; 325 to 395°C). The equilibrium adsorption constant distribution on a Co/Mo-$\gamma Al_2O_3$ catalyst was measured using the same pulsed flow method described earlier for model compounds. Results have shown that the CDL distillate fractions consist of materials exhibiting lnK/sub ads/ values from 3.4-6.6. A bimodal distribution is observed with, presumably, the heteroatom containing molecules exhibiting adsorption 1 to 2 orders of magnitude greater than the hydrocarbons. Theoretical considerations reveal that two orders of magnitude is sufficient to effectively displace weaker adsorbing species. This finding is highly significant to CDL processing and may help explain the rationale for their poor response to catalytic hydroprocessing. 17 figs., 4 tabs.

6436 **(DOE/PC/70802—T4) Coal liquefaction study under the nonisothermal reaction temperature. Quarterly progress report, July-September 1986.** Kwon, K.C. (Tuskegee Univ., AL (USA). Dept. of Chemical Engineering). 1986. Contract FG22-84PC70802. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002016.

Effects of heating rates on liquefaction of Kentucky No. 9 coal were investigated in the presence of various hydrogen donor solvents and powdery NiMo/alumina catalyst as part of Task 2. A series of coal liquefaction runs were conducted for Kentucky No. 9 coal, increasing coal liquefaction temperatures from 200°C or 300°C up to 380°C. The main objectives of this study are to: investigate effects of heating rates on catalytic activities of powdery NiMo/alumina catalyst; understand roles of hydrogen donor solvents; study effects of initial liquefaction temperatures on coal liquefaction; and evaluate effects of hydrogen donor solvents on product distributions in the early stages of liquefying Kentucky No. 9 coal in the presence of powdery NiMo/alumina catalyst at nonisothermal liquefaction temperatures. 18 figs., 5 tabs.

6437 **(EPRI-AP—4832) Cool Water Coal Gasification Program. Fourth annual progress report.** (Cool Water Coal Gasification Program, Daggett, CA (USA); Bechtel Power Corp., Houston, TX (USA); Radian Corp., Austin, TX (USA)). Oct 1986. 224p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920050.

This report provides an update on the Cool Water Coal Gasification Program and supplements EPRI Report AP-2487 published in July 1982, Report AP-3232 published in October 1983 and Report AP-3876 published in January 1985. Details of the first year of commercial operation are described in this report on the 100 MW integrated gasification - combined cycle (IGCC) demonstration plant. This includes a description of plant performance, plant dynamic control modes, environmental monitoring and reliability/availability statistics. A description of process changes made during 1984 and 1985 is accompanied by photographs of new equipment installations. A summary of the operation and test plans for the five-year demonstration period is provided. An update of the costs for the plant by functional section is included. The sources of funding for the project are defined including a summary of the Participant's equity position. The first-year plant operating and miscellaneous costs are also summarized. This document is the fourth in a series of annual reports on the progress of the Cool Water Project, from design through testing and operations. 21 figs., 54 tabs.

6438 **(NP—7770030) Formation and occurrence of benzpyrene in coking plants.** Schaefer, N. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 11 Jan 1985. 146p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87770030.

The work gives a survey on the formation of benz-pyrene in the coking process of hard coal, where starting from the coal structure, the origin of the BaP and the pyrolytic formation and synthesis of BaP and the pyrolytic formation and synthesis of BaP in coking ovens is described. Measurements for dust particles, which are bound to PAH in air, are then introduced. As particles which reach the lungs are mainly of interest from the point of view of hygiene, there is a survey of the grain size analysis process, which is suitable for determining this dust. As in assessing dust, the surface properties of the particles are important, the different morphological methods of examination using microscopes, electron microscopes and electron grid microscopes are discussed. In the results from eight dust samples, which were collected at different places in a coking plant, it was found by gas chromatography examination that the coke dusts only had a small PAH content, while the corresponding proportion of PAH in dried solids from filling truck suction was much higher. One could see on electron microscope photographs that the PAH did not combine with dust particles, but was deposited like a nest on the surface of the particles. The grid electronics photographs showed that the dusts examined consisted of sharp-edged particles, which could be identified as quartz particles from calibration photographs. No connection could be found between the size of the specific surface or the grain size range of the dust and the PAH content.

6439 **(NP—7770031) Kinetics of grain size alteration of hard coal in pyrolysis and hydropyrolysis.** Loewenthal, G. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Fachbereich Chemie). 27 Jun 1984. 178p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE87770031.

Using the wire mesh technique, the production formation kinetics and the course of grain sizes in pyrolysis and hydropyrolysis of three different gas flame coals was examined in a pressure reactor. In order to measure the product formation, about 10-20 mg of coal of the sieve stage 0,8-1,0 mm were heated at a constant speed of heating of 210 k/sec at a pressure of 90 bar. The sample was introduced between the folded mesh surfaces like a sandwich, so that intensive thermal contact between the mesh and the coal was guaranteed. As continuous analysis of the products during the heating process was not possible, the release of the individual components was compiled from a large number of individual measurements with different final temperatures. Values for the kinetic parameters were obtained for the components methane, ethane, ethene, carbon monoxide, carbon dioxide, hydrogen, tar and for the loss of weight. The numerical values were accessible directly from the experimental data. The product formation could be described by a reaction of order n=1 and one of order n=2.

6440 **(PB—86-245438/XAB) Low-Btu gasification wastewater technical support document. Technical report.** (Environmental Protection Agency, Washington, DC (USA)). Jul 1986. 236p. NTIS, PC A11/MF A01.

The purpose of the document is to present the process and effluent data that were collected and analyzed by the EPA from 1979 to 1981 on the low-Btu gasification industry. It is hoped that this information will be useful to permit writers, industry, and the general public when determining appropriate wastewater pollution control systems for the low-Btu gasification industry. The term low-Btu gasification in the document concerns air-blown gasifiers using coal as the primary feedstock and producing a gas with a heating value of approximately 150 Btu/SFC. Information is provided on the status of the low-Btu gasification industry, wastewater characterization, production process descriptions, and wastewater treatment technologies.

## 0106 Properties

*REFER ALSO TO CITATION(S) 6404, 6432, 6435, 6465, 6470, 7508*

6441 (DOE/METC—86/6042, pp 334-342) **Design and calibration of Morgantown Energy Technology Center's alkali fiber optic spectrometer.** Romanosky, R.R. Jr.; Hensel, P.J.; Schaeffer, S.; Logan, R.G. Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The Morgantown Alkali Fiber Optic Spectrometer (MAFOS) is capable of detecting total sodium and total potassium in process slipstreams at concentrations ranging from less than 1 part per billion to 80 parts per million. Since the MAFOS generates real-time (30-second intervals) alkali values over a wide concentration range, the transient characterization, as well as long term alkali monitoring, of either dirty or cleaned streams is possible. The sample enters the unit's high temperature flame which supplies energy to both decompose and excite the sample, which then emits light at the characteristic wavelengths of sodium and potassium. The resulting emissions are transferred by the fiber optic bundle to the detection system, where the signal is filtered, background corrected, and transferred to the data system. The data system processes and quantifies the signal, and displays the results simultaneouly on a video screen and a line printer. The new alkali unit was designed to be a compact, rugged, on-line, extractive alkali monitor. It has been designed to require little manpower intervention, and incorporates features such as computer controlled electronic and flame balancing, background correction, automated gain switching, and automated flameout sensing and shutdown. Additionally the computer system stores the raw data and has software features which allows the data to be redisplayed or edited at a future time.

6442 (DOE/METC—86/6042, pp 343-347) **Hot gas alkali determination.** Haas, W.J. Jr.; Eckels, D.E. (Ames Lab., IA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract W-7405-ENG-82.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objectives of this study are to: monitor alkali concentrations in support of Gas Stream Cleanup activities at various field sites, as directed by the Project Officer; conduct comparative evaluations of the performance of the Ameas and METC alkali monitors where possible as part of that work; prepare written guidance for sampling of hot gas streams and transport of hot gas sample streams to alkali monitoring equipment in a manner that will yield a representative sample for alkali determination; provide training concerning the operation of the alkali monitor to personnel at sites specified by the Project Officer, and participate in initial alkali monitoring efforts at those sites as part of the training effort. This paper presents the guidelines pertinent to hot gas sampling for continuous alkali; monitoring and the calculations for alkali monitoring with the double sampling approach. 8 references.

6443 **(DOE/PC/50801—T2) Laser induced coal fluorescence. Final technical report.** Borst, W.L. (Southern Illinois Univ., Carbondale (USA). Dept. of Physics). 13 Jun 1986. Contract FG22-82PC50801. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012197.

The novel application of time-resolved fluorescence techniques to organic petrology is a significant extension of fluorescence spectral analysis of the composition and degree of coalification of microscopic organic material. Characteristic lifetimes and time-resolved emission spectra can be acquired for the various components producing liptinite fluorescence. The fluorescence decay of a variety of liptinites can be resolved into two distinct temporal components, one in the nanosecond range and the other in the subnanosecond range. For some resinites of the Hiawatha Coal, three fluorophores can be recognized. This improvement in coal characterization also indicates that time-resolved fluorescence analysis can be applied to the examination of dispersed organic material in sedimentary rocks, where the morphology of kerogen is frequently physically altered by sedimentary processes. Thus, this technique can be used to fingerprint obscure fluorescing bodies and may also aid in the troublesome identification of sporinite and alginite in sedimentary rocks. This new laser microscopy technique offers the first explanation of documented fluorescence trends of sporinite with increasing coal rank. Our results indicate that this shift toward the red and loss of sporinite fluorescence intensity with increasing rank is due to changing percentage from each fluorophore. Since the percentages of the fluorophores in sporinite vary systematically with the high-volatile A bituminous coals, new rank parameters based upon these percentages can be developed. Percentages can be used in conjunction with vitrinite reflectance when there is evidence of reflectance suppression, a dearth of vitrinite, or where questions exist about the nature of the vitrinite distribution. 12 refs., 27 figs., 4 tabs.

6444 **(DOE/PC/70006—T6) Enthalpy and phase behavior of coal derived liquid mixtures. Ninth quarterly technical progress report, July-September 1986.** Yesavage, V.F.; Kidnay, A.J. (Colorado School of Mines, Golden (USA). Dept. of Chemical Engineering and Petroleum Refining). 31 Oct 1986. Contract FG22-84PC70006. 70p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001895.

On July 15, 1984, work was initiated on a program to study the enthalpy and phase behavior of coal derived liquid moedl compound mixtures. During the ninth quarter, enthalpy measurements on the pure component 1-methylnaphthalene were obtained. Also, during this quarter ternary vapor liquid equilibrium measurements for m-cresol/quinoline/tetralin have begun for the isotherms; 250, 275, 300, 325°C. A maximum likelihood algorithm applicable for implicit constraints has been developed. The method was applied to the determination of interaction parameters for temperature and density dependent mixing rules from our binary vapor liquid equilibrium data. 16 refs., 51 figs., 14 tabs.

6445 **(DOE/PC/80532—5) On line multielement determination of coal slurries using a direct current plasma.** McCreary, T.W.; Yoon, R.; Long, G.L. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemistry). 30 Oct 1986. Contract FG22-85PC80532. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001906.

In this fourth quarter of research, we feel that we have established a preliminary mechanism for chemical reactions that may occur in the direct current plasma (DCP) relative to organic species. Briefly, the organic species created by dissociation of propane (or any organic compound) in the plasma cause a depression in the emission signal seen with most elements under normal plasma conditions. By reducing the argon flow to the sleeves, the organic species is better entrained within a plasma "plume", and the desirable organic/metal oxide reactions can occur, with a consequent enhancement of signal. This first year's work will be detailed in a paper to be submitted to Applied Spectroscopy for publication; a preliminary copy of this paper is attached. Coal samples are being prepared for analysis using the DCP. Unfortunately, the Babington nebulizer which was constructed for this work did not provide a signal-to-noise ratio that was suitable for slurry work. We have ordered a Babington nebulizer which was specifically designed for the direct current plasma; this nebulizer should arrive in early November, at which time the slurry studies will begin.

6446 **(DOE/PC/80533—T4) Structural characterization/correlation of calorimetric properties of coal fluids. First annual report, September 1, 1985-August 31, 1986.** Starling, K.E.; Mallinson, R.G.; Li, M.H.; Peters, M.W.; Hulvey, R.D. (Oklahoma Univ., Norman (USA). School of Chemical Engineering and Materials Science). 1986. Contract FG22-85PC80533. 73p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002017.

The objective of this research is to examine the relationship between the calorimetric properties of coal liquids and their molecular functional group composition. Coal liquid samples which have had their calorimetric properties measured are characterized using proton NMR, ir and elemental analysis. These characterizations are then used in a chemical structural model to determine the composition of the coal liquid in terms of the important molecular functional groups. These functional groups are particularly important in determining the intramolecular based properties of a fluid, such as ideal gas heat capacities. Correlational frameworks for heat capacities will then be examined within an existing equation of state methodology to determine an optimal correlation. Also, the optimal recipe for obtaining the characterization/chemical structure information and the sensitivity of the correlation to the characterization and structural model will be examined and determined. 7 refs.

6447 **(DOE/PETC/TR—87/4) Structural definition of synthetic fuels: H-coal distillates.** Schmidt, C.E.; Perry, M.B.; White, C.M.; Gibbon, G.A.; Retcofsky, H.L. (USDOE Pittsburgh Energy Technology Center, PA). 1986. 65p. NTIS, PC A04/MF A01; GPO Dep. File Number DE87002513.

This work describes the progress made on a Pittsburgh Energy Technology Center research project titled "Structural Definition of Synthetic Fuels." An H-Coal product consisting of a blend of "light" and "heavy" oils was distilled into 50°F boiling cuts. Mid-boiling temperature, specific gravity, molecular weight by several techniques, refractive index, and viscosity were determined for each H-Coal distillate. Structural parameters for each 50°F distillate cut were elucidated from nuclear magnetic resonance and low-voltage, high-resolution mass spectrometric analyses. Preparative liquid chromatography was used to obtain functionality enriched fractions of saturates, aromatics, acids, and bases from the H-Coal distillates. Several correlations have been found from these extensive data sets and are discussed and interpreted in terms of findings from previous investigations. The potential for developing mathematical models relating the aromaticity from nuclear magnetic resonance results and the structural parameter, Z, from mass spectrometry with the inspection properties of the H-Coal pseudocomponents is demonstrated. Average chemical structures for each distillate are proposed based on the analytical results. 25 refs., 17 figs., 13 tabs.

6448 **(NP—7750518) Additives for coal water slurries.** (Bayer A.G., Leverkusen (Germany, F.R.)). [1986]. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750518.

The production of coal slurries with a solids-content of more than 60% by wt. is impossible in practice without using chemical additives. The choice of additive will depend on the desired properties of the coal slurry. The following compounds are used as ad-

ditives: - dispersants, - stabilizers against sedimentation, e.g. cellulose derivatives, guar or xanthan gum or water-soluble polymers, - other auxiliaries such as corrosion inhibitors, defoaming agents, electrolytes etc. The dispersants form the most important group of additives. A variety of ionic and nonionic compounds and polymers have been tested.

6449 **(NP—7770029) On the depolymerization of oil originating from hard coal and of petroleum bitumen by means of the Beckmann conversion of the oxidation products.** Radecke, R. (Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet). 11 Jan 1985. 123p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE87770029.

The splitting of methylene bridges between aromatic units represents a way of depolymerizing high molecular substances of non-standard structure, such as oil and bitumen. Photo-bromiding is done for the oxidating activation of these substances which are difficult to split. Apart from the desired attack on the benzyl methylene groups, there is also core bromiding. As is shown by spectroscopic data and hydrolysis experiments one can assume charge, transfer or surface adsorption phenomena. In order to avoid the disadvantages of a multiphase reaction, the permanganate anion is changed to the organic phase by a phase transfer catalyst, which oxidises the completely dissolved initial substances in a homogeneous reaction. This considerably increases the speed of reaction with a simultaneous reduction of the required reaction temperature. The yield of oxidation products was increased between 10 and 50 times. The bitumen oxidation products probably originate from the resin. By suitable processing, it was possible to obtain four fractions, which were oxidised very little to very greatly. The oximes obtained after conversion with hydroxylamine are accessible by a specific splitting reaction, the Beckmann conversion. It occurs in mild conditions and does not attack the original structures.

6450 **(PB—86-243748/XAB) Towards a methodology for breaking carbon-carbon bonds in coal macromolecules. Topical report, July 1985-July 1986.** Arnett, E.M.; Chawla, B.; Amarnath, K.; Whitesell, L.G. (Duke Univ., Durham, NC (USA). Dept. of Chemistry). Jul 1986. 31p. NTIS, PC A03/MF A01.

Heats of heterolysis have been measured for eight C-C and C-O bonds from the reaction of resonance-stabilized ions in 95% Sulfolane/5% 3-methylsulfolane solution at 25°C. The results followed a simple master equation delta H(sub het) = 11.98-1.178 p(K sub R+) + 1.156 pKa) derived from readily accessible stability constants for the carbocations, carbanions, and phenoxide ions used to form the bond.

6451 **Structural characteristics of polycyclic aromatic hydrocarbon isomers in coal tars and combustion products.** Nishioka, M.; Chang, H.C.; Lee, M.L. (Brigham Young Univ., Provo, UT). *Environmental Science and Technology;* **20**: No. 10, 1023-1027(Oct 1986). Contract AC02-79EV10237.

Isomeric polycyclic aromatic hydrocarbons (PAH) with two to six rings in coal-derived products and in a carbon black were separated, identified, and quantified by using capillary column gas chromatography and gas chromatography-mass spectrometry. A newly synthesized smectic liquid-crystalline polysiloxane and a conventional polymethylsiloxane were utilized as stationary phases. Many previously difficult to separate isomeric PAH (i.e., methylphenanthrenes/methylanthracenes, triphenylene/chrysene, methylchrysenes, benzofluoranthenes, and pentaphene/benzo[b]chrysene) were identified). The relative abundances of the PAH in these samples were compared and correlated to the reaction conditions during their production. The relationship between abundance and structure for the identified PAH was also discussed. 26 references, 5 figures, 1 table.

6452 **Application of automated image analysis to the study of mineral matter in raw and processed coals.** Straszheim, W.E. Ames, IA; Iowa State Univ. (1986). 364p. University Microfilms Order No. 86-15,092.Contract W-7405-ENG-82.

Thesis (Ph. D.).

Automated image analysis (AIA) and scanning electron microscopy was developed and applied to the characterization of mineral matter in two series of processed coals. Fundamental factors for the application of image analysis to the characterization of minerals in coal which were addressed include development of chemistry definitions for classification of minerals in coal, sampling design, characterization of mineral matter mass distributions by size and type for both raw and processed coals, and AIA overestimation of pyritic sulfur. A formula was developed for designing AIA analyses so that adequate sample area and particles may be analyzed to produce reliable and reproducible results. AIA was applied to the characterization of mineral matter in samples of 200 mesh Illinois No. 6 (Illinois), Pittsburgh (West Virginia), Adaville No. 11 (Wyoming), and Dietz No. 1 and 2 (Montana) coals before and after float-sink cleaning, and to the characterization of samples of Illinois No. 6 and Pittsburgh No. 8 coals before and after cleaning with the TRW Gavimelt molten caustic (NaOH-KOH) process. AIA provided a method to identify statistically significant differences in mineral matter features among the coals studied, such as the distribution among mineral phases (e.g., predominant mineral phases being different from one coal to another), the difference in size distribution (i.e., especially after cleaning), and the ability to monitor the formation of new phases associated with chemical cleaning. Factors leading to AIA overestimation of pyritic sulfur by as much as 50% were evaluated. Porosity in large particles of pyrite was found to be the most significant reason for overestimation of pyrite.

## 0108 Waste Management

*REFER ALSO TO CITATION(S) 6395, 6397, 6401, 6404, 6405, 6428, 6440*

6453 **(DOE/METC—86/6042, pp 24-36) Solid collectors for control of emissions.** Klinzing, G.E.; Blachere, J.R. (Univ. of Pittsburgh, PA). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21387.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The research initiated and reported in this paper has the objective to control the emission of alkali metals, trace metals and aromatic hydrocarbons that occur in advanced coal conversion processes as exemplified in pulverized coal combustion. The attack for solution of this problem consists of two interacting investigating groups. The combustion engineering group investigated candidate collector solids injected into a pulverized coal flame, collected from the flue gases and later characterized. The coal fuels vary in rank and trace contents. The combustion conditions provide a range of oxidizing and reducing atmospheres, temperature, trace component concentration and residence or transit times for the particles. The characterization is carried out by the materials engineering group. The collectors being tested cover a range of chemical and mineralogical composition, particle size and pore sizes. The materials engineering group utilizes electron microscopy and microprobe analysis as well as mercury porosimetry, nitrogen adsorption isotherms, and other analytical techniques to examine and characterize the collector solids before and after passage through the flame, and to determine the distribution of adsorbed species. Particle morphology, size and element distribution have been determined for the collector, the coal ash and the feed material. The combustion system, analytical techniques, and results to date are described. 14 references.

6454 **(DOE/PETC/TR—87/1) Annotated bibliography of liquid and solid waste treatment for coal conversion processes.** George, E.J.; Noceti, R.P. (USDOE Pittsburgh Energy Technology Center, PA). Oct 1986. 208p. NTIS, PC A10/MF A01; GPO Dep. File Number DE87002510.

Bibliographies of topics in science have the primary purpose of assembling scattered literature on a specific topic in a single document. The field concerning the treatment of liquid and solid wastes resulting from coal conversion processes has been heavily investigated for the past 15 to 20 years. This bibliography consists of 837 selected references taken from journal publications, private and governmental reports, and textbooks published during the past 12 years (1974-1985). Each reference has been coded according to a bibliography key sheet. This key has 8 primary headings, which are

further broken down into various descriptive subtopics. A computerized listing that cross references the individual codes with their corresponding bibliography numbers has been included in order to present a rapid means of selecting topics of primary interest. The list of references primarily represents coal conversion processes, such as coal gasification, coal liquefaction, and underground gasification.

6455 **(IS-M—564) Co-utilization of fly ash and flue gas scrubber sludge in the lime-sinter process.** Burnet, G.; Murtha, M.J. (Ames Lab., IA (USA); Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Chemical Engineering). 1986. 8p. (CONF-8610155—1). NTIS, PC A02/MF A01. File Number DE86011433.

From 18. annual frontiers of power conference; Stillwater, OK, USA (28 Oct 1986).

One of the most important technical issues of the 80's is the effective and economical disposal or utilization of solid wastes. In the case of coal wastes, the electric utility, the end user, the regulatory community, and the public share responsibility for taking action. Ash and flue gas desulfurization sludge produced annually in the United States alone total over 90 million tons and only a small fraction is utilized. The increased use of coal to generate electricity and of scrubbers to reduce SO/sub x/ emissions add to the urgency of developing sound waste management options. The lime-sinter process for the recovery of alumina from fly ash provides a means for co-utilization of the ash and sludge. The sludge is used as a mineralizer and partial replacement for the limestone. Extractable alumina-containing compounds are formed and high alumina yields result at moderate sintering temperatures. The process residue formed shows promise as a raw material for the manufacture of portland cement. 11 refs., 9 figs., 3 tabs.

6456 **(IS-M—588) Kinetic studies of the carbochlorination of dispersed metal oxides in a molten salt reactor.** Dobbins, M.S.; Burnet, G. (Iowa State Univ. of Science and Technology, Ames (USA); Corning Glass Works, NY (USA)). 1986. Contract W-7405-ENG-82. 30p. (CONF-861146—6). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001860.

From AIChE winter annual meeting; Miami, FL, USA (2 Nov 1986).

The carbochlorination of alumina and of mixed oxides slurried in a stirred melt of NaCl-$AlCl_3$ using chlorine was investigated. Reaction rates and the reaction mechanism were determined at temperatures of 530 to 800°C by sampling the contents of the reactor during operation and by analyzing the off gases using a direct coupled gas chromatograph. The effects of carbon and oxide loading, salt composition and amount of agitation were studied. Alumina chlorination was significantly influenced by an interaction between carbon and chlorine. At temperatures below 650°C, alumina chlorination was kinetically controlled, while gas-liquid mass transfer was limiting at higher temperatures. Chlorination rates for the mixed oxides of Al, Si and Fe found in power plant pulverized coal ash were strongly influenced by the dissolution rate of the oxides. 14 refs., 9 figs., 2 tabs.

6457 **(NP—7770028) Kinetic investigation of the simultaneous removal of sulphur dioxide and nitrogen oxides from stack gases by the Bergbau-Forschung.** Hoang-Phu, T. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Fachbereich Energie-, Verfahrens- und Elektrotechnik). 27 Jun 1984. 154p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87770028.

This work determines the kinetics of the simultaneous removal of nitrogen oxides and sulphur dioxide using NH/sub 3/ on active carbon. The catalytic reduction of NO by NH/sub 3/ on active carbon is best described by a Langmuir-Hinshelwood mechanism. The concurrent reaction of SO/sub 2/ with NH/sub 3/ occurred much more quickly than the reduction of NO by NH/sub 3/ . Ammonium salts were formed, which are released, in thermal desorption using carbon, as SO/sub 2/, N/sub 2/ and CO/sub 2/. The comparison of the calculated results with the output of simultaneous removal plants at Takehara, Luenen and Tochigi shows that the kinetic data determined in this work are very suitable for the design of technical reactors. One goes back to the transfer of the kinetic results from the active carbon A examined to the material used, where structural data for the latter are available. In the design of technical scale plant consisting of two bed reactors after one another, in particular, the reaction model can predict the degree of separation in the 2nd stage satisfactorily. The addition of NH/sub 3/ can be selected so that the NH/sub 3/ outlet concentration does not exceed a given limit. The reduction of NO can be extended to conversion percentages above 80 or 90% with suitable design of the reactor. Thus future tasks in limiting the NO/sub x/ emission can be fulfilled.

6458 **(PB—86-237740/XAB) Sulfur capture with limestone injection in cyclone combustion flow. Final report, 17 September 1982-15 April 1983.** Zauderer, B. (Coal Tech Corp., Merion, PA (USA)). Apr 1983. 95p. NTIS, PC A05/MF A01.

An analytical study was performed to identify the phenomena responsible for the observed 25-35% sulfur capture with limestone injection in a laboratory-scale cyclone coal combustor. The study's primary objective was to determine the feasibility of using this sulfur-control process in a commercial-scale cyclone, suitable for oil-fired-boiler conversion to coal. The methodology used consisted in separately analyzing the processes occurring during heatup, devolatilization, and char burnup of coal particles, and in the calcination, sulfur capture, and sulfur re-evolution reactions of the limestone in the gas and slag covered wall of the cyclone.

6459 **(PB—86-244845/XAB) Report on the survey of abandoned uraniferous lignite mines in southwestern North Dakota.** Lyon, R.J.; Prochaska, D.; Burgess, J.L.; Patrick, D. (Office of Radiation Programs, Las Vegas, NV (USA)). Mar 1986. 59p. (EPA—520/1-86/013). NTIS, PC A04/MF A01.

A radiation survey was conducted in October 1983 as part of the proposed reclamation plan of abandoned uraniferous lignite mines in southwestern North Dakota. The survey was made to determine the extent of contamination caused by mining operations in the 1960's. Radiation measurements were made and soil samples were taken at approximately 300 locations around six mine sites comprising eleven lignite mine pits. Toxic element analysis was also done on 50 of the soil samples.

6460 **Electron beam removal of $SO_2$ and NO/sub x/ from flue gas.** Helfritch, D.J.; Feldman, P.L. (Cottrell Environmental Sciences, Somerville, NJ). pp 106-119 of Proceedings of the 3rd symposium on integrated environmental controls for fossil-fuel power plants. Pittsburgh, PA; Air Pollution Control Association (1986). (CONF-860207—).

From 3. symposium on integrated environmental control; Pittsburgh, PA, USA (4 Feb 1986).

The use of an electron beam for the removal of $SO_2$ and NO/sub x/ from the flue gas of coal fired boilers has been evaluated by means of pilot scale experiment. In addition to an electron beam, the complete FGD system utilizes a lime slurry spray dryer and a fabric filter. The results of the pilot scale tests are used to design and cost estimate a full-scale system.

## 0109 Environmental Aspects

*REFER ALSO TO CITATION(S) 6438*

6461 (LBL—20261, pp 1-3) **Primary sulfuric acid emissions: an interdisciplinary study.** Amdur, M.O.; Sarofim, A.F.; Bolsaitis, P.; McCarthy, J.F. (Massachusetts Institute of Technology, Cambridge, MA). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Combustion of fossil fuels and smelting of metals produce both $SO_2$ and ultrafine ($<0.1$ μm) metal oxide aerosols. These can interact to produce sulfuric acid as a primary emission from coal burning utility boilers or smelters. The sulfuric acid may be present as a surface layer coating the ultrafine aerosol or as the free acid. The toxicology (which predicts potential health effects) of $SO_2$-aerosol systems is governed by the specific nature of the particulate

sulfur species formed; the problem thus is interdisciplinary. The authors present specific data, but they also offer an example of what can be learned only by an integrated research approach to such problems.

6462 (LBL—20261, pp 47-48) **Empirical evidence for heterogeneous $SO_2$ oxidation in Ljubljana, Yugoslavia.** Bizjak, M.; Hudnik, V.; Hansen, A.D.A.; Novakov, T. (Boris Kidrich Institute of Chemistry, Ljubljana, Yugoslavia). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The research described in this paper deals with certain aspects of heterogeneous formation of aerosol sulfate in Ljubljana, Yugoslavia. This location is well suited for such a study because of high pollutant concentrations, especially during winter. Space heating, in a large number of dispersed individual furnaces and a few larger central heating plants, is the principal source of $SO_2$ during the winter. Because relatively low-grade coal is burned in inefficient combustors, large soot concentrations are observed in the winter. During the relatively cold winters, inversions with characteristic pollution-induced urban fog occur almost daily. This paper discusses the results from the 1981/1982 and 1983/1984 sampling periods.

## 0130 Transport And Handling

*REFER ALSO TO CITATION(S) 6448*

6463 (DOE/PC/62684—T2-Pt.1) **Computer simulation of coal preparation plants. Part 1. Mathematical procedures. Final report.** Gottfried, B.S.; Tierney, J.W. (Pittsburgh Univ., PA (USA)). Dec 1985. Contract AC22-83PC62684. 91p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86015391.

This report describes a comprehensive computer program that allows the user to simulate the performance of realistic coal preparation plants. Use of the simulator requires that the user specify the appearance of the plant configuration, the plant operating conditions, and a description of the coal feed. The simulator will then determine the flowrates within the plant, and a description of each flowrate (i.e., the weight distribution, percent ash, pyritic sulfur and total sulfur, moisture, and Btu content). The simulation program has been written in modular form using the Fortran language. It can be implemented on a great many different types of computers, ranging from large scientific mainframes to IBM-type personal computers with a fixed disk. Part I of this report contains a general description of the methods used to carry out the simulation. Each of the major types of units is described separately, in addition to a description of the overall system analysis. Part II is intended as a user's manual. It contains a listing of the mainframe version of the program, instructions for its use (on both a mainframe and a microcomputer), and output for a representative sample problem. 22 refs., 9 figs., 1 tab.

6464 (DOE/PC/70003—T11) **Coal pretreatment for two stage liquefaction. Quarterly report, July 1-September 30, 1986.** Derbyshire, F.J.; Luckie, P.T. (Pennsylvania State Univ., University Park (USA). Coll. of Earth and Mineral Sciences). 1986. Contract FG22-84PC70003. 25p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002202.

A quantity of liquefaction feedstock was prepared from the subbituminous coal, PSOC-1401, by size-density separation. Approximately 380 g of 1.4 s.g. float fraction hhas been made available for autoclave experiments. Work has continued in studying the pretreatment of a subbituminous coal by liquid-liquid extraction using a heptane-water system. Results using added surfactants have so far shown little benefit to mineral matter rejection. The autoclave operation has been improved by introducing larger cold traps on the exit gas line, which have overcome earlier problems caused by blockages, and by using higher speeds of impeller rotation. The results of earlier research, which showed the advantages of temperature-staged catalytic liquefaction in tubing bomb reactors, have now been confirmed on the stirred autoclave system. However, the magnitude of the effects due to different operating conditions is somwhat suppressed on the larger scale. This is attributed to differences in agitation, hydrogen pressure and heat-up times. To circumvent the slow heat-up periods in the autoclave, a high pressure coal injector system has been installed. Noncatalytic and catalytic experiments have been conducted to examine the operability of the system. It has been found to be extremely reliable and provide reproducible data. The liquefaction behaviors of a subbituminous coal (PSOC-1401) and a 1.4 s.g. float fraction, preapred by size-density fraction, have been compared in noncatalytic experiments. Under these conditions, the parent coal gave somewhat better results in terms of net conversion and oil yields. A comparison of the liquefaction of these coals in catalytic experiments is currently being made. 5 refs., 7 tabs.

6465 (DOE/PC/80530—T3) **Carbon dioxide for fine coal flotation. Annual progress report, September 1985-September 1986.** Miller, J.D. (Utah Univ., Salt Lake City (USA). Dept. of Metallurgy). 30 Sep 1986. Contract FG22-85PC80530. 47p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001909.

Preliminary research has demonstrated the potential for the production of superclean coal by a carbon dioxide flotation technique. In this regard, a detailed research effort on the fundamentals of coal flotation by carbon dioxide was initiated in September 1985. During the past year, research has been carried out on different aspects of the problem including hydrophobic characterization, bench-scale flotation, adsorption from the gas phase, electrokinetic behavior, and FTIR spectroscopy for coals of different rank. The hydrophobic character has been established by bubble attachment-time measurements and contact-angle measurements by means of a high-speed video system and an electronic induction timer. Bench-scale flotation experiments have provided an indication of the effectiveness of carbon dioxide flotation on the more practical side in terms of mineral matter rejection and flotation rate. By combining the studies of adsorption density, electrokinetic behavior, and FTIR spectroscopy, the characterization regarding the specificity and interaction of carbon dioxide at the coal surface has been examined. This annual report presents the major results and progress from the research effort made in the past year. A better understanding for carbon dioxide flotation has already been achieved although the program has not yet been completed. 28 refs., 21 figs., 12 tabs.

6466 **Fuel agglomerates and method of agglomeration.** Wen, W.W. (to Dept. of Energy, Washington, DC). US Patent 4,615,712. 7 Oct 1986. Filed date 9 Aug 1985. vp.

A method is described of producing water-resistant carbonaceous agglomerates suitable for use as a fuel comprising: providing a solid, oxidized carbonaceous material including chemically combined oxygen as humic acid or humate salt; extracting humates from the oxidized material into aqueous alkali solution to form a binder solution; providing particulate carbonaceous fuel material having a heating value greater than that of the oxidized carbonaceous material; blending the binder solution in mixture with the particulate fuel to permeate the humate solute into the fuel particles; consolidating the particulate fuel into agglomerates of convenient size for fuel use; and drying the agglomerates to reduce moisture content and convert the humate solute into a solid, water-resistant binder material throughout the agglomerate.

6467 **Status of clean coal technologies.** Poundstone, W. (Clean Coal Technology Panel, DOE Energy Research Advisory Board). pp 43-50 of New energy technologies for Illinois and the midwest. Springfield, IL; Illinois Dept. of Energy and Natural Resources (1985). (CONF-8510324—).

From 13. annual Illinois energy conference; Chicago, IL, USA (28 Oct 1985).

In this presentation the author reviews current industry practice and discusses some of the new approaches currently being investigated in the field of pre-combustion coal cleaning. Until recently, coal cleaning was carried out for economical rather than environmental reasons, with the principal goal being to reduce the mineral matter (ash content) of coal. The degree of cleaning and thermal drying for moisture control has historically been determined by the amount needed to achieve the lowest total cost for mining, transporting, and converting coal to other forms of energy. However, not all coals are, or need be, cleaned for economic rea-

sons. Sometimes the most favorable overall economics can frequently be achieved by selective mining (this is especially true in the case of surface mined coal). With the passage of the Clean Air Act, coal cleaning has been employed for many coals as a means of reducing their sulfur content.

## 0140 Combustion

*REFER ALSO TO CITATION(S) 6625*

6468 **(DOE/FE/60181—2128) Low-rank coal-water slurry combustion: Final report for the period ending June 30, 1986.** Hauserman, W.B.; Patel, R.C.; Brown, R.A.; Hurley, J.P.; Steadman, E.; Jones, M.L. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Sep 1986. Contract FC21-83FE60181. 87p. NTIS MF A01; 2; GPO Dep. File Number DE87001016.

The combustion behavior of Hot-Water-Dried slurries of selected low rank coals was investigated during a three year program, using the 550,000 Btu/hr ash fouling furnace at the University of North Dakota Energy Research Center. Combustion of the slurries presented no additional problems of handling, feeding, flame stability or carbon burnout compared to powdered coals or inburning commercial bituminous coal slurries. Heating values of the slurries ranged from 5600 to 7400 Btu/lb, with solids loadings of 55 to 60%. Essentially complete (99%+) carbon burnout was achieved in all tests. Furnace operating conditions included fuel residence time of three seconds, and an exit furnace temperature of 2000°F. Compared with powdered coal, the flame produced in slurry combustion is distributed further through the furnace combustion zone, with lower peak temperatures than observed with powdered coal combustion. For three of the four coals studied, the weight of ash deposits on simulated boiler tubes per weight of total ash input was lower for slurry combustion than for powdered coal. In the case of one subbituminous coal, however, the amounts of the deposits were greater than the deposits produced in powdered coal combustion. There was no significant difference in the combustion behavior of slurries prepared at different temperatures by hot water drying. However, x-ray diffraction analyses of deposits produced in combustion of powdered coal, indicates that mineral species present were predominantly simple oxides and sulfates, while for deposits produced in combustion of slurry, tube fouling deposits were primarily of complex aluminosilicates. This evidence indicates that the combustion characteristics of slurries do have some differences and effects on character of the ash deposits. 38 refs., 19 figs., 4 tabs.

6469 (DOE/METC—86/6042, pp 37-47) **Provide alkali species profiles using a well-characterized coal combustor.** Greene, F.T.; O'Donnell, J.E.; Robaugh, D. (Midwest Research Institute, Kansas City, MO). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—). Contract AC21-84MC21091.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

This research requires the use of both a well-characterized coal combustor/reactor and an analytical technique capable of quantitatively measuring gaseous oxides, hydroxides, and other reactive and condensible species present at high temperatures and pressures. The analytical technique selected, molecular beam mass spectrometry, could be used with a wide variety of coal combustors. In the coal combustor/reactor selected either a single coal particle or an array of particles react under conditions which simulate those of a PFBC or gasifier, and the species evolved are measured as a function of time. The use of this type of reactor has the advantages of providing an analysis of the species leaving the particle surface, which can be directly applied to many models, and of providing exceptional control of the experimental variables, including pressure, temperature, flow velocity, gas composition, and particle size. In addition to the gaseous species, measurements are being made of the composition of the coal/ash particle and the temperatures of the combustion gases and the particle as a function of time. Preliminary data for sodium evolution and some of the combustion parameters obtained for three coals (bituminous, subbituminous, and lignite) as a function of temperature, pressure, and gas composition are given. 12 references.

6470 **(DOE/METC—87/4067) Design and operating characteristics for a laboratory coal-water fuel droplet generator.** Maloney, D.J.; Fasching, G.E.; McCarthy, L.A.; Lawson, W.F.; Casleton, K.H. (USDOE Morgantown Energy Technology Center, WV). Oct 1986. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001003.

A coal-water fuel (CWF) or slurry droplet generator has been developed for use in laboratory-scale studies of CWF combustion phenomena. The droplet generator design is based on ink-jet printer technology and offers the capability of delivering, on demand, a stream of slurry droplets of uniform size and composition. To date, reliable operation has been achieved for slurries with coal loadings up to 40% by weight. Monodisperse constant diameter CWF droplet streams have been produced with droplet diameters ranging from $< 100$ μm up to 300 μm. The droplet generator currently is being employed to investigate the initial stages of CWF droplet combustion. 5 refs., 9 figs., 4 tabs.

6471 **Research and technology to market Illinois coal.** Beaver, M. (Energy & Environmental Affairs Div., Illinois Dept. of Energy & Natural Resources). pp 51-58 of New energy technologies for Illinois and the midwest. Springfield, IL; Illinois Dept. of Energy and Natural Resources (1985). (CONF-8510324—).

From 13. annual Illinois energy conference; Chicago, IL, USA (28 Oct 1985).

This paper discusses new coal technologies and the prospects for commercial success of Illinois coal. Fluidized-bed technology is highly efficient and allows combustion at much lower temperatures than conventional stoker-fired boilers. In addition, FBC technology can provide effective control of sulfur dioxide gases when limestone is added to the combustion chamber. It is possible to remove more than 90 percent of the sulfur in combustion gases when the correct proportion of limestone is added to the bed. The low combustion temperatures also inhibit the production of nitrous oxides. The first project to receive support from the Illinois Coal Bond Fund demonstrated an early coal-fired FBC system at Great Lakes Naval Training Center. Later generations of fluidized-bed combustion technologies were sponsored at Midwest Grain Products, Inc., the BF Goodrich Chemical Group plant, and Clayton & Co. These FBC demonstrations are of great significance to the advancement of boiler design. The prospects for commercial success of new coal technologies, especially the new industrial boiler technologies are very promising. In order to stimulate the market penetration of these systems, the State of Illinois has established an industrial coal utilization loan program which will offer low interest loans.

## 0150 Marketing And Economics

*REFER ALSO TO CITATION(S) 6471*

## 0160 Health And Safety

*REFER ALSO TO CITATION(S) 6438, 7483*

# 02 PETROLEUM

*REFER ALSO TO CITATION(S) 6393*

## 0202 Geology And Exploration

*REFER ALSO TO CITATION(S) 7396, 7397*

6472 **Deep convergent margin petroleum basins of the Circum-Pacific.** Cohen, K.K.; Gwilliam, W.J.; Anderson, T.H.; Lidiak, E. (Department of Energy, Morgantown, WV). *American Association of Petroleum Geologists, Bulletin;* 70: No. 7, 916(Jul 1986). (CONF-8608105—).

From 4. circum-Pacific energy and mineral resource conference; Singapore, China (17 Aug 1986).

The US Department of Energy is investigating whether hydrocarbons can be generated from unconventional deep basins associated with convergent boundaries along the Circum-Pacific margin. Magnetotelluric studies conducted by the US geological Survey have located two deep-seated features in Washington that have high electrical rock conductivities. These two deep features, which may represent sites of paleoconvergent deposition, include a deeply buried basin in western Washington and rocks underlying the Methow Trough of north-central Washington. Subsurface interpretations in these two areas are handicapped by sparse and shallow well data. In western Washington, the deep high conductivity rock units are overlain by unrelated volcanic, plutonic, and other upper crustal rocks, and are inaccessible for surface investigations; in the Methow Trough, rocks directly related to underlying deeper rock units are exposed. These exposed rocks provide a unique opportunity to investigate the related strata that exist at greater depths. A primary goal of the research was to establish whether these deeply emplaced rocks could or did generate hydrocarbons. Geochemical and thermal maturation techniques were used to investigate the hydrocarbon potential of the Methow Trough deep rocks, and results from these techniques are compared to results from other Circum-Pacific convergent margin basins. Paleobasin reconstruction studies were used to better constrain the mode of emplacement, burial time and depths, and temperature history of deep rock units in the Methow basin. These investigations will be applied to other identified deep convergence-related basins elsewhere in the Circum-Pacific as the search for unconventional deep petroleum basins and a new hydrocarbon resource continues.

6473 **Facies architecture and production characteristics of strand-plain reservoirs in North Markham-North Bay City field, Frio Formation, Texas.** Tyler, N.; Ambrose, W.A. (Univ. of Texas Bureau of Economic Geology, Austin). *American Association of Petroleum Geologists, Bulletin;* 70: No. 6, 809-829(Jun 1986). Contract AC08-79ET27111.

The North Markham-North Bay City field, Matagorda County, Texas, produces oil and gas from multiple barrier and strand-plain sandstones of Oligocene age stacked over a rollover anticline in the Frio fault zone. Three principal oil reservoirs-the Cayce, Cornelius, and Carlson- account for 83% of the 49 million bbl produced from the field. All three were deposited in strand-plain systems and display considerable heterogeneity. The Cayce reservoir is composed of beach-ridge plain, distributary, and deltaic facies. Reservoir heterogeneity results in anisotropic fluid behavior. Water influx in the beach-plain deposits follows broad fronts, whereas water invasion in channel deposits is more restricted and erratic. The Cornelius reservoir was deposited in a system intermediate between sand-rich beach plains and mud-rich chenier plains. Sandy beach ridges, separated by muddy swales, compose the productive framework of this class of strand-plain reservoir and act as conduits for early water influx. Sandstones, possibly of washover origin, in the intervening swales produce oil but are more rapidly drained than are beach-ridge sandstones. The Carlson reservoir produces from transgressed strand-plain deposits. The Carlson had a complex and episodic depositional history, yet water-influx and oil-production maps suggest isotropic fluid behavior. Modern sand-rich transgressive shore-zone deposits are characteristically sheet-like, as is the transgressive component of the Carlson reservoir. This distinctive morphology appears to have fostered reservoir productivity. Oil recovery follows predictable trends. Recovery efficiency is highest from the transgressive sheet sands of the Carlson, intermediate from the composite Cayce, and lowest from the depositionally complex and mud-rich Cornelius.

6474 **1983 Landsat soil-gas geochemical survey of Patrick Draw area, Sweetwater County, Wyoming.** Richers, D.M.; Jones, V.T.; Matthews, M.D.; Maciolek, J.; Pirkle, R.J.; Sidle, W.C. (Marathon International Oil Co., Houston, TX). *American Association of Petroleum Geologists, Bulletin;* 70: No. 6, 869-887(Jun 1986).

The Geosat test site at Patrick Draw, Wyoming, was resampled during the summer field season of 1983, to conduct a more detailed soil-gas survey on and around the area's producing fields. The results of this study agree with the 1980 Geosat assessment that the faults and fractures visible as linear features on satellite and aircraft imagery provide paths for active microseepage of hydrocarbons from depth to the near surface. This association is particularly true near the earlier described blighted sage zone, where extensive resampling reveals a much wider area of anomalously high free soil-gas values and fluorescence than was previously reported. Discriminant analysis suggests that the geochemical seepage signature found over the fields differs statistically from that present for adjacent areas of no known production. This observation was found to be true for all three soil-gas techniques used in this study. Anomaly patterns appear to be related to the type of soil-gas sample studied. Data obtained from shallow free soil-gas samples reveal that direct anomalies, controlled by faults and fractures, formed over production, whereas data obtained from samples treated by acid-extraction or thermal/mechanical disaggregation techniques exhibit magnitude lows over the producing areas. Such patterns indicate halo features around the composite producing areas. At present, this conflicting behavior cannot be explained.

## 0203 Drilling And Production

6475 **(PB—86-245099/XAB) Numerical mud-discharge plume model for offshore-drilling operations. Final report.** Multer, R. (Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Hydraulics Div.). Jul 1985. 32p. NTIS, PC A03/MF A01.

The mathematical basis of the model is a unidirectional, steady, Reynolds-type diffusion equation. To close the governing equation, coefficients of eddy diffusion are introduced and a hypothesis of similar mass and momentum diffusion invoked to define them. Also made is an assumption that the velocity may be replaced by its mean over the depth. The substitution facilitates separation of the original equation into two partial differential equations. One equation models the effect of lateral diffusion and is solved analytically. The other equation models the interaction of settling, longitudinal transport, and vertical diffusion and is solved numerically.

6476 **(PB—86-246170/XAB) Indicators of the direct economic impacts due to oil and gas development in the Gulf of Mexico, results of year 1.** (Centaur Associates, Inc., Washington, DC (USA)). Jan 1986. 704p. NTIS, PC PC E99.

Set includes PB—86-246188 through PB—86-246204.

6477 **(PB—86-246188/XAB) Indicators of the direct economic impacts due to oil and gas development in the Gulf of Mexico: results of year 1. Volume 1. Executive summary.** (Centaur Associates, Inc., Washington, DC (USA)). Jan 1986. 36p. NTIS, PC A03/MF A01.

See also Volume 2, PB—86-246196; Also available in set of 3 reports PC E99, PB—86-246170.

The study investigated the direct employment and salary impacts of oil and gas activities on the Federal Outer Continental Shelf in the Gulf of Mexico during 1984. The study also documented the geographic distribution of these impacts. Primary data for the study were provided by nine major oil and gas operations in the Gulf of Mexico and by several contractors to these companies.

6478 **(PB—86-246196/XAB) Indicators of the direct economic impacts due to oil and gas development in the Gulf of Nexico: results of year 1. Volume 2. Narrative.** (Centaur Associates, Inc., Washington, DC (USA)). Jan 1986. 115p. NTIS, PC A06/MF A01.

See also Volume 1, PB—86-246188 and Volume 3, PB—86-246204; Also available in set of 3 reports PC E99, PB—86-246170.

The study investigated the direct employment and salary impacts of oil and gas activities on the Federal Outer Continental Shelf in the Gulf of Mexico during 1984. The study also documented the geographic distribution of these impacts. Primary data for the study was provided by nine major oil and gas operations in the Gulf of Mexico and by several contractors to these companies.

6479 **(PB—86-246204/XAB) Indicators of the direct economic impacts due to oil and gas development in the Gulf of Mexico: results of year 1. Volume 3. Exhibits and data.** (Centaur Associates, Inc., Washington, DC (USA)). Jan 1986. 556p. NTIS, PC A24/MF A01.

See also Volume 2, PB—86-246196; Also available in set of 3 reports PC E99, PB—86-246170.

The study investigated the direct employment and salary impacts of oil and gas activities on the Federal Outer Continental Shelf in the Gulf of Mexico during 1984. The study also documented the geographic distribution of these impacts. Primary data for this study were provided by nine major oil and gas operations in the Gulf of Mexico and by several contractors to these companies.

6480 **Vertical interference pressure testing across a low-permeability zone with unsteady crossflow.** Wijesinghe, A.M.; Kececioglu, I. Richardson, TX; Society of Petroleum Engineers (1986). 15p. (CONF-861080—). Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836.

From Society of Petroleum Engineers annual technical conference and exhibition; New Orleans, LA, USA (5 Oct 1986).

Existing analytical models for interpreting vertical interference pressure tests across the low permeability zone in a three-layered reservoir usually assume transient radial flow in the high permeability layers and pseudo-steady vertical crossflow in the intervening tight zone. The neglect of vertical flow in the high permeability layers, and the neglect of radial flow in the tight layer, requires the permeability contrast between these layers to be large. However, when this assumption is satisfied, it is also very likely that the pressure diffusivity in the tight layer is much smaller than that in the high permeability layers. Thus, to be consistent, the flow across the tight layer must be treated as an unsteady diffusive process driven by the transient pressure changes occurring in the high permeability layers. In this paper, the authors extend the analysis by replacing their pseudo-steady crossflow assumption with unsteady crossflow and interpret the crossflow response in terms of near- and far-boundary flow response functions for the tight zone. The inclusion of unsteady crossflow requires one additional dimensionless parameter and results in a set of governing equations that are different from, but are similar to, the equations of the dual-porosity dual-permeability model with unsteady interporosity flow.

6481 **Combined effects of shut-in and production: Solution with a new inner boundary condition.** Correa, A.C.; Ramey, H.J. Jr. Richardson, TX; Society of Petroleum Engineers (1986). 16p. (CONF-861080—). Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836.

From Society of Petroleum Engineers annual technical conference and exhibition; New Orleans, LA, USA (5 Oct 1986).

A new approach was used to solve the problem of pressure buildup following constant bottom hole pressure production. Previous methods of solution involve finite difference solution or numerical evaluation of the superposition integral. An analytical solution correct for both the flowing and shut-in periods was obtained by solving the diffusivity equation with a single inner boundary condition which included the mixed conditions for flow and buildup. Both a skin effect and wellbore storage were included even though the production period was at constant wellbore pressure. Solution was obtained by Laplace transformation. The procedure presented in this paper may be used to solve other interesting problems. One example presented is the joint solution of constant rate production and shut-in with wellbore storage and skin effect. The procedure used does not involve superposition. As a consequence it is recommended to increase the field specific mixing energy to a value as close as possible to the API one. This provides optimum slurry quality and good similarity between laboratory and field conditions.

## 0204 Processing

*REFER ALSO TO CITATION(S) 6498*

## 0205 Products And By-products

*REFER ALSO TO CITATION(S) 7485*

6482 **(AD-A—171893/1/XAB) Antimisting kerosene. Evaluation of improved FM-9 additive. Final report, August 1983-November 1984.** Yavrouian, A.; Parikh, P.; Sarohia, V. (Jet Propulsion Lab., Pasadena, CA (USA)). Jun 1986. 63p. (JPL-PUB-D—2581). NTIS, PC A04/MF A01.

Optimization of FM-9 dissolution rate to attain both acceptable mist suppression and degradation properties within 15 to 20 minutes of in-line blending was carried out by Imperial Chemical Industries (ICI). This report discusses the evaluation of the FM-9 with improved dissolution rate and, consequently, better degradability characteristics for compatibility with engine filters and fuel-control systems. This additive was identified as a candidate additive to be used in a Control Impact Demonstration (CID) test. The major findings of the investigations are: 1) Quality of the FM-9 slurry meets the metering and dispersion requirements for single stage, in-line blending. 2) The dissolution rate at ambient fuel temperatures (15-20 C) is sufficient, and produces AMK fuel with adequate fire suppression in 30 minutes after blending. 3) Freshly blended fuel can be degraded without difficulty with a specific power requirement of less than 30 kWsL-1. 4) Contamination with large amounts of bulk water leads to formation of gelled emulsion on the interface. The water vapor condensation of AMK surfaces produced a string-like second phase. 5) Low-temperature evaluation indicated no phase separation and gel-formation problems. 6) Significant loss in pumpability performance with FM-9 AMK was observed at both room and low temperature using the Cessna 441 boost pump. However, the deterioration of pumpability performance was not as significant with AMK as compared with Jet A using the DC-10 boost pump.

6483 **(DOE/FE/60600—T5) Petroleum reservoir engineering support for the Office of Naval Petroleum and Oil Shale Reserves. Final technical report.** (Evans, Carey and Crozier, Bakersfield, CA (USA)). Oct 1986. Contract AC01-85FE60600. 44p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001394.

In accordance with the "Procedures for the Determination and Approval of Maximum Efficient Rates of Production from the Naval Petroleum Reserves" issued by the Office of Naval Petroleum and Oil Shale Reserves, US Department of Energy, dated January 1985, the proposed MER for the NWS A4-A6 reservoirs is herewith submitted. The subject Task Assignment was explicit as to certain operational restraints within which the MER determinations were to be made. In the case of the NWS A4-A6 reservoirs, these restraints were limited to a specification of the water injection rates, i.e., gradually building up to and maintaining an injection rate of 22,000 barrels water per day. Accordingly, the proposed MER results in an average of 8575 BOA/D for the six-month period ending March 31, 1987, and 8662 BOA/D for the nine-month period ending mid-year 1987. We believe that these rates will be both attainable and sustainable, and will be a reasonable target which is justified in terms of both maximizing ultimate recovery and providing a suitable economic return. The study was performed in the manner prescribed by the Department of Energy. It was based on the reservoir study which was made by Evans, Carey and Crozier, and which had an effective date of May 1, 1986. The proposed MER differs from that in the study only as a result of injection rates which vary slightly from those assumed in the latter. Each of the sections of this MER proposal contains a discussion, if appropriate, plus such graphical or tabular presentations as are necessary to explain and/or support the conclusions contained therein.

6484 **(PB—86-232238/XAB) Environmental considerations relating to the petrochemicals industry. Sectoral Working Paper Series, No. 40.** (United Nations Industrial Development Organization, Vienna (Austria)). Nov 1985. 19p. (UNIDO-IS—580). NTIS, PC PC E03/MF E01.

Petrochemicals include a wide variety of compounds. The following six industries are considered in this paper: synthetic rubbers, synthetic fibers, organic petrochemicals, plastics, carbon black, and surfactants. Contents include: Introduction; Environmental considerations; Air pollution control; Wastewater treatment and disposal; Solid-waste management; Hazardous-wastes control; Energy use; Industrial growth; Management philosophy; Responses.

6485 **(PB—86-243565/XAB) Manganese-modified asphalts: chemistry of the curing action, its effect on properties. Final report, October 1981-April 1985.** Petersen, J.C.; Plancher, H. (Western Research Inst., Laramie, WY (USA)). Jun 1986. 55p. NTIS, PC A04/MF A01.

The chemical reactions and reaction kinetics of asphalt modified with a patented modifier supplied by Chemkrete Technologies, Inc. were investigated. The modifier, a manganese-carboxylic acid complex, was shown to cause a rapid reaction with atmospheric oxygen when the modified asphalt is exposed as thin films. The reaction produces paving mixtures with increased stiffness and tensile strength. In the present study, a good correspondence was found between the manganese-induced oxidation reaction (cure) and the increase in asphalt viscosity.

## 0207 Marketing And Economics

*REFER ALSO TO CITATION(S) 6483*

6486 **(BNL—38750) US offshore oil and gas production.** Kroon, M.W. (Brookhaven National Lab., Upton, NY (USA)). Sep 1986. Contract AC02-76CH00016. 52p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002399.

Following the introduction, contents of this report includes background information, which covers chemical composition of hydrocarbons, geology and ocean environment, and process of field development. Process field development include: overview of the process; federal and state leasing policies; geological and geophysical exploration; drilling (drill bit and drill string, hoisting system, circulating system, power plant, blowout prevention systems, riser system); exploratory drilling (jack-up drilling units, semisubmersibles, drillships, barges and submersibles); field development drilling (production platforms, template platforms, concrete gravity platforms and tension leg and guyed tower platforms); and transportation systems (pipelines and tankers). 30 refs., 4 figs., 2 tabs.

6487 **(BNL—38751) Offshore petroleum industry activity and associated costs.** Kroon, M.W. (Brookhaven National Lab., Upton, NY (USA)). Sep 1986. Contract AC02-76CH00016. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002398.

This paper summarizes historical data on the level of activity in the processes of offshore petroleum production, from leasing to production. It also summarizes estimates of the cost of pursuing these activities, as of 1985. Costs vary with conditions, equipment, field size and water depth so that it is hard to define a single representative cost that is meaningful. Instead a range of drilling costs per well, both exploratory and developmental, are presented with a lower and upper bound. Total costs are presented in graphic form. Total exploratory costs include lease acquisition, geological and geophysical exploration and the approximately 9 to 17 dry and delineation wells, as well as successful exploratory wells. Development costs include development wells, the platform(s) facilities, equipment, operations and transportation for oil. Gas is usually sold to a pipeline company at the wellhead. 17 refs., 1 fig., 12 tabs.

## 0208 Waste Management

*REFER ALSO TO CITATION(S) 7386*

6488 **Model hydrodesulfurization reactions: saturated $C_4S$ molecules on Mo(110).** Roberts, J.T.; Friend, C.M. (Harvard Univ., Cambridge, MA). *Journal of the American Chemical Society;* **108**: No. 23, 7204-7210(12 Nov 1986). Contract FG02-84ER13289.

The reactions of tetrahydrothiophene and 1-butanethiol on Mo(110) have been investigated by using temperature-programmed reaction spectroscopy, isotopic exchange reactions, and Auger electron spectroscopy. At low exposures, tetrahydrothiophene decomposes below 400 K to gaseous dihydrogen and surface carbon and sulfur. Higher tetrahydrothiophene exposures also result in reaction limited formation of butane and butene at 350 and 380 K, respectively. Preadsorption of a saturation coverage of hydrogen or deuterium atoms decreases the temperature at which butane is formed by 50 K and increases the yield of butane by a factor of approximately 6 at reaction saturation. The butene formation peak is unaffected by the presence of excess surface hydrogen. Reversible desorption of molecularly bound tetrahydrothiophene from the Mo(110) surface is observed at 310 K. In the absence of preadsorbed hydrogen, approximately 25% of the tetrahydrothiophene that reacts forms hydrocarbons, as measured by Auger electron spectroscopy. An irreversibly bound hydrocarbon fragment is present on the surface which decomposes at 565 K to produce gaseous dihydrogen. The butane, butene, and dihydrogen incorporate surface deuterium. The proposed mechanism for this reaction is initial hydrogenation of one of the $\alpha$-carbon atoms with accompanying C-S bond scission.

## 0209 Environmental Aspects

*REFER ALSO TO CITATION(S) 7376, 7385, 7386, 7387, 7388, 7389, 7390, 7391, 7392, 7393, 7394, 7395, 7401, 7485*

6489 (LBL—20261, pp 35-37) **Primary sulfate emissions from oil-fired power plants.** Gordon, G.E.; Olmez, I. (Univ. of Maryland, College Park). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Much of the airborne sulfate in the eastern US results from $SO_2$ gas released far upwind followed by slow conversion during transit. Because of the regional nature of the problem, urban sulfate concentrations do not greatly exceed rural values in a particular area. Although the importance of regional sulfate in urban areas is clear, local sources may contribute significant fractions of sulfate to the air of eastern US cities, especially during winter. Direct calculations of primary sulfate contributions to urban areas are difficult to make, but estimates can be made for oil-fired plants relative to particulate V concentrations, as receptor-model calculations for eastern US cities indicate that most airborne V originates from oil combustion. As most V and sulfate from oil-fired plants is borne by fine particles (diam $< 2.5$ $\mu$m), the authors consider only fine or non-crustal $V_s$ and sulfate.

## 0250 Combustion

*REFER ALSO TO CITATION(S) 6625*

6490 **Results of studies on soot production and fouling in oil-fired condensing systems.** Butcher, T.A.; Celebi, Y.; Piraino, M.; McDonald, R. (Dept. of Applied Science, Brookhaven National Lab.). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* **92**: No. 1B, 683-694(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

The development of condensing heat exchangers for oil-fired heating equipment would yield a significant improvement in thermal efficiency. Soot production by oil burners, however, could lead to fouling problems in these systems. Results are reported on tests done to evaluate the effect of operating conditions on start-up and shutdown smoke production in both noncondensing and condensing furnaces. Parameters studied included burner excess air, draft condition, operating cycle, and heat exchanger system resistance. During start-up there is a momentary pressure peak in the combustion chamber as gas expansion occurs. This peak reduces fan airflow, leading to fuel-rich conditions and soot. After shutdown heavy soot can also be formed in condensing systems unless there is a brief, forced airflow through the combustion chamber. In the absence of an airflow, heat soak-back from the combustion chamber overheats the fuel nozzle assembly leading to afterdrip and soot formation. Modern retention head burners, which are commonly used in the U.S., were included as well as one European burner with some different design features. These features included the head design, a fuel shut-off in the nozzle tip, and nozzle heating. This burner was found to produce less smoke on start-up and shutdown than the common U.S. burner.

# 03 NATURAL GAS

*REFER ALSO TO CITATION(S) 6393*

## 0302 Geology And Exploration

*REFER ALSO TO CITATION(S) 6473, 7396, 7397*

## 0303 Drilling, Production, And Processing

*REFER ALSO TO CITATION(S) 6475, 6476, 6477, 6478, 6479, 6480*

6491 **Inhibition of gas hydrates by methanol.** Anderson, F.E.; Prausnitz, J.M. (Univ. of California, Berkeley, CA 94720). *A.I.Ch.E. Journal (New York);* **32**: No. 8, 1321-1333(Aug 1986).

A molecular-thermodynamic correlation has been developed for calculating the inhibition effect of methanol on the formation of hydrates in moist gas mixtures. Six phases are potentially present in these mixtures: gas, aqueous liquid, hydrocarbon liquid, ice, and hydrate structures I and II. For a given temperature and system composition, the molecular-thermodynamic method described allows computation of the hydrate-point pressure as well as relative amounts and compositions of all coexisting phases. Good agreement is obtained when calculated results are compared with diverse experimental data reported in the literature. The correlation given here may be useful for computer-aided design for gas processing and transportation.

6492 **Interference testing: Detecting an impermeable or compressible region.** Sageev, A.; Horne, R.N. Richardson, TX; Society of Petroleum Engineers (1986). 8p. (CONF-861080—). Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836.

From Society of Petroleum Engineers annual technical conference and exhibition; New Orleans, LA, USA (5 Oct 1986).

A practical consideration of the effects of a single circular heterogeneous reservoir subregion on interference transient pressure testing is presented. The production well and the observation wells are external to the circular subregion. The internal circular boundary is considered as a constant pressure source or as an impermeable subregion. The constant pressure subregion has significant effects on interference pressure responses regardless of the size of the subregion. Ignoring the presence of a neighboring compressible portion of the reservoir, such as a gas or a steam cap, may yield erroneously high storativities and transmissivities. Multiple inference tests may suggest the probable location of the gas cap. The effects of an impermeable subregion are subtle, and in some cases large impermeable portions of the reservoir may not be detected by neighboring interference wells. Some interference tests in the presence of an impermeable subregion may yield high values of reservoir storativities, stemming from a pressure response similar in shape to the line source response. A map of the positions of interference wells that do not permit the detection of an impermeable subregion is presented.

## 0304 Products And By-products

*REFER ALSO TO CITATION(S) 6484*

## 0306 Marketing And Economics

*REFER ALSO TO CITATION(S) 6486*

## 0308 Environmental Aspects

*REFER ALSO TO CITATION(S) 7376, 7385, 7387, 7388, 7389, 7390, 7391, 7392, 7393, 7394, 7395*

## 0309 Artificial Stimulation

6493 (LBL—21850, pp 268-270) **Coupled model for fluid-driven fractures.** Heuze, F.E.; Shaffer, R.J.; Ingraffea, A.R. (Lawrence Livermore National Lab., CA). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The Unconventional Gas Program at Lawrence Livermore National Laboratory is pursuing research in the stimulation of tight gas reservoirs. The enhancement of gas recovery is based on creating large induced fractures in an otherwise naturally jointed medium. The mechanics of stimulation involve the coupling of fluid flow, rock deformation, non-linear joint behavior and mixed-mode fractures mechanics. A finite element model, FEFFLAP which accounts for the coupling of these various mechanics was developed and verified on physical experiments.

## 0320 Transport, Pipelines, And Handling

*REFER ALSO TO CITATION(S) 6491*

6494 **A model of Constant Tensile Load Test data for polyethylene pipe materials.** Raske, D.T. (Materials Science & Technology Div., Argonne National Lab., Argonne, IL). pp 168-181 of Proceedings of the ninth plastic fuel gas pipe symposium. Arlington, VA; American Gas Association (1985). (CONF-851158—).

From 9. plastic fuel gas pipe symposium; New Orleans, LA, USA (12 Nov 1985).

This paper describes the development of an analytical model for constant tensile load test (CTLT) data obtained on commercial polyethylene (PE) pipe materials. The primary objective of this study was to assess and describe the mechanical behavior of PE materials in support of a program to improve the long-term reliability and performance of these materials in fuel-gas distribution systems. Thus, the model was developed in order to compare, rank, and extrapolate the results of CTLT experiments as an aid in the formulation of an improved product. This model is a non-linear regression analysis relationship between the applied nominal stress and the observed time to failure, and accounts for different material lots or test conditions. The paper describes the basis for the functional form of the model as well as the model's ability to describe CTLT data.

6495 **Chemical characterization of polyethylene resins and polyethylene gas pipe.** Raphaelian, L.A.; Ettinger, D.G. (Argonne National Lab., Argonne, IL). pp 304-318 of Proceedings of the ninth plastic fuel gas pipe symposium. Arlington, VA; American Gas Association (1985). (CONF-851158—).

From 9. plastic fuel gas pipe symposium; New Orleans, LA, USA (12 Nov 1985).

A variety of analytical techniques were used to characterize, chemically, some commercial PE pipe samples. With /sup 13/C NMR, ethyl, butyl and long branches (greater than five carbons) were found. The range of branching was 1.7 to 5.6 branches per thousand backbone carbons. With GC/MS, a surprising number of n-alkenes, that is, oligomers or very low molecular weight polyethylene molecules, were found. On a molecular basis, the total

number of very low molecular weight polyethylene molecules is of the same order as the number of all the other polyethylene molecules of higher molecular weight. Also, a variety of additives or degradation products were present: antioxidants and their oxidized forms, lubricants such as soaps, silicones, and glycerol, and cyclic aromatics such as anthracene, phenanthrene, etc. With XRD, with the exception of one PE pipe, differences in crystallite size and degree of orientation of the crystallites were found between the interior and exterior of the pipe. This probably arises during processing due to rapid cooling on the outside of the pipe relative to the inside giving rise to smaller crystallites in the outer surface.

### 0340 Combustion

*REFER ALSO TO CITATION(S) 6788*

6496 **(PB—86-245883/XAB) Development of PC 4 dual-fuel engine.** Nishikawa, T.; Utsuyama, S.; Maruyama, S.; Ono, T.; Kitahara, S. (Nippon Kokan K.K., Tokyo). 1985. 9p. NTIS, PC PC E04/MF E01.

Included in Nippon Kokan Technical Report No. 45: Overseas, 62-70, Dec 1985.

Recently, utilization of natural gas, which is considered to be one of most important alternative fuels for petroleum, has been marked. As thermal efficiency of dual-fuel engine is higher than those of other prime movers with gaseous fuel, i.e., spark-ignited gas engine or gas turbine, it is possible to construct fuel-economical gas power plants with dual-fuel engines. However, its horsepower has been limited to the rather lower range. In 1984, NKK succeeded in developing large-sized dual-fuel engines based on the Pielstick PC4 diesel engine. The horsepower is 1200 HP/cyl, i.e. 21,600 HP for 18-cyclinder engine.

### 0350 Storage

6497 **Insulating polymer concrete for LNG impounding dikes.** Steinberg, M.; Fontana, J. (Brookhaven National Lab., Upton, LI, NY). pp 1-2 of Proceedings of the eighth international conference on liquefied natural gas. Chicago, IL; Institute of Gas Technology (1986). (CONF-860617—).

From 8. international conference and exposition on liquified natural gas; Los Angeles, CA, USA (16 Jun 1986).

An insulating polymer concrete (LPC) material has been developed to cost and insulate the surfaces of impounding dikes surrounding LNG storage tanks. IPC consists of a lightweight aggregate, such as expanded perlite or sealed hollow glass modules bound with a resin such as an unsaturated polyester resin. The composite is ideally suited to cover the surfaces of impounding dikes for safety, reducing the boil-off rate of LNG in the event of an LNG spill. IPC materials have low thermal conductivities ranging from 0.08 to 0.15 BTU/hr-ft-°F which is as much as 25 times less than conventional concrete, have low water absorption (<2%) thus maintaining durability and insulating properties under adverse weather conditions and have compressive strengths ranging from 1000 to 3000 psi allowing bearing support for maintenance, personnel, and equipment. IPC density varies from 30 to 60 lbs/ft/sup 3/. The IPC can be applied in precast panels or cost-in-place overlays to concrete or other dike substrates. Bonding and sealing are important properties in the case of precast panels while workability and shrinkage are important factors to be taken into account for casting overlays of IPC on concrete or other substrates. The benefit derived in significantly reducing the boil-off rate appears to warrant the cost of applications of IPC.

## 04 OIL SHALES AND TAR SANDS

*REFER ALSO TO CITATION(S) 6393*

### 0404 Oil Production, Recovery, And Refining

6498 **(AD-A—171565/5/XAB) Turbine fuels from tar-sands bitumen and heavy oil. Part 2. Phase II. Laboratory sample production. Interim report, 1 October 1983-31 October 1985.** Talbot, A.F.; Elanchenny, V.; Schwedock, J.P.; Swesey, J.R. (Sun Refining and Marketing Co., Marcus Hook, PA (USA)). May 1986. 123p. NTIS, PC A06/MF A01.

The conversion of domestic tar-sands bitumens or heavy crude oils into aviation turbine fuels was studied in small scale equipment to demonstrate the process scheme consisting of hydrovisbreaking the bitumen or crude residuum follwed by catalytic hydrotreating or hydrocracking of the resultant naphtha or distillate fractions. Four different feedstocks were employed; two were bitumens (from Kentucky or Utah) and two were heavy crudes from California. Significant operating parameters were examined for each process step. Prototype naphtha and kerosene-type fuel samples compared well with JP-4 and JP-8 specifications, although fuels prepared from Utah bitumen (Sunnyside deposit) were deficient in freeze point. Initiation of Phase III, pilot-plant-scale evaluation of the process is recommended.

6499 **(SAND—86-1608C) Application of laboratory results to the design of a high yield VMIS oil shale retort.** Bickel, T.C.; Ricketts, T.E. (Sandia National Labs., Albuquerque, NM (USA); Science Applications International Corp., La Jolla, CA (USA)). 1986. Contract AC04-76DP00789. 13p. (CONF-861146—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001738.

From AIChE winter annual meeting; Miami, FL, USA (2 Nov 1986).

In situ oil shale retorts have typically been designed to process a rubble bed having uniform cross-sectional rubble properties. Edge effects during rock fragmentation commonly produce increased void at the perimeter of these low-void retorts. Previous laboratory and field results have demonstrated this void variation normal to the direction of flow causes non-uniform retort front velocities that result in significantly lower oil yield. It is unlikely that process control parameters (e.g., multiple injection points, steam, etc.) can provide any significant yield improvement in these non-uniform retorts. Any large improvement would come from modified rubblization concepts. This paper describes a modification to the retort blast design to achieve a uniform retorting front velocity in rubble with non-uniform properties (void fraction and particle size). This concept requires the creation of an anisotropic rubble bed with varying particle size and void fraction normal to the direction of flow. The unavoidable increased void at the retort perimeter is offset by modifying the ratio of the effective particle size of the rubble in the central to the perimeter regions of the retort. The results of laboratory-scale pressure drop and retorting experiments with an empirical blast design technique are used to describe how a high-yield, second generation in situ retort would be designed. 12 refs., 7 figs.

6500 **Apparatus for oil shale retorting.** Lewis, A.E.; Braun, R.L.; Mallon, R.G.; Walton, O.R. (to Dept. of Energy, Washington, DC). US Patent 4,619,738. 28 Oct 1986. Filed date 2 Aug 1984. v.p.

This patent describes an apparatus for retorting oil shale particles of variable size, including fines, comprising: a substantially vertical cascading burner having a pair of opposing walls; vertically spaced baffles extending from the opposing walls of the burner inwardly and downwardly into the burner in an overlapping relationship, successive baffles extending alternately from opposing walls of the burner the baffles. The baffles comprise a first segment and a second segment connected to and above the first segment and having a slope greater than the first segment. The first segment has a slope, measured from the horizontal, in the range of about 24° - 60°; a substantially vertical cascading mixer below the burner, the

burner being mounted to the mixer and communicating therewith through an opening therebetween, the mixer having a pair of opposing walls; vertically spaced baffles extending from the opposing walls of the mixer inwardly and downwardly into the mixer in an overlapping relationship, successive baffles extending alternately from opposing walls of the mixer; raw shale input means mounted to the top of the mixer adjacent to the burner and communicating with the mixer through an opening therebetween; a substantially vertical moving packed bed pyrolyzer below the mixer, the mixer being mounted to and opening into the pyrolyzer; spent shale removal means connected at the bottom of the pyrolyzer and communicating with the pyrolyzer through an opening therebetween; and product removal means operatively connected to the pyrolyzer.

### 0410 Environmental Aspects

*REFER ALSO TO CITATION(S) 7293*

## 05 NUCLEAR FUELS

### 0501 Reserves, Exploration, And Mining

*REFER ALSO TO CITATION(S) 7426*

### 0504 Feed Processing

*REFER ALSO TO CITATION(S) 6909*

6501 **(PB—86-244076/XAB) Standard test methods for the strong-base resins used in the recovery of uranium.** Ford, M.A.; Lombaard, L.R. (Council for Mineral Technology, Randburg (South Africa)). 30 May 1986. 43p. (MINTEK-M—245). NTIS, PC PC E03/MF E01.

The report describes test methods that are relevant to the ion-exchange recovery of uranium. They include tests of the physical properties of strong-base resins (relative density, particle-size distribution, and moisture content) and of their chemical properties (theoretical capacity, equilibrium capacity, kinetics of loading and elution). Included are several supporting procedures that are used in conjunction with these methods.

### 0505 Uranium Enrichment

*REFER ALSO TO CITATION(S) 6578*

### 0507 Fuels Production And Properties

*REFER ALSO TO CITATION(S) 6673*

6502 **Improved laboratory assays of Pu and U for SRP purification and finishing processes.** Holland, M.K.; Dorsett, R.S. (E.I. du Pont de Nemours & Co., Inc., Savannah River Plant, Aiken, SC 29808). *Nuclear Materials Management;* **15**: 162-169(1986). (CONF-860654—). Contract AC09-76SR00001.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Significant improvements have been made in routine assay techniques for uranium and plutonium as part of an effort to improve accountability at the Savannah River Plant (SRP). Emphasis was placed on input/output accountability points and key physical inventory tanks associated with purification and finishing processes. Improvements were made in existing assay methods; new methods were implemented; and the application of these methods was greatly expanded. These improvements are discussed in detail.

### 0508 Spent Fuels Reprocessing

*REFER ALSO TO CITATION(S) 6913, 7218*

6503 **(CEA-CONF—8420) Comparison of numerical and physico-chemical models for on-line spectrophotometric control of uranium.** Corriou, J.P.; Boisde, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 13p. (CONF-8604263—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750244.

From ANATECH '86; Noordwijkerhout, Netherlands (22 Apr 1986).

In view of on-line spectrophotometric control of fuel reprocessing streams, a physico-chemical model able to predict uranium and nitric acid concentrations in an uranyl nitrate-nitric acid system has been searched. Thus the influences of the following parameters: uranium, nitrate, hydrogen ion concentrations, ionic strength, on the equilibria of complexation of uranium (VI) nitrate have been evaluated. Extinction coefficients for the uranium mononitrate and uranium dinitrate complexes are given between 410 and 440 nm. The apparent equilibrium constants are determined as a function of the ionic strength. The limitations of this predictive model are emphasized and comparisons with numerical models are discussed. (16 refs).

6504 **PUMA - a new mathematical model for the rapid calculation of steady-state concentration profiles in mixer-settler extraction, partitioning, and stripping contactors using the Purex process.** Geldard, J.F. (Los Alamos National Lab., Los Alamos, NM 87545). *Nuclear Technology;* **75**: No. 2, 160-167(Nov 1986). Contract W-7405-ENG-36.

The mathematical basis for a computer code PUMA (Plutonium-Uranium-Matrix-Algorithm) is described. The code simulates steady-state concentration profiles of solvent extraction contactors used in the Purex process, directly without first generating the transient behavior. The computational times are reduced, with no loss of accuracy, by about tenfold over those required by codes that generate the steady-state profiles via transient state conditions. Previously developed codes that simulate the steady-state conditions directly are not applicable to partitioning contactors, whereas PUMA is applicable to all contactors in the Purex process. Since most difficulties are encountered with partitioning contactors when simulating steady-state profiles via transient state conditions, it is with these contactors that the greatest saving in computer times is achieved.

### 0509 Transport And Storage

*REFER ALSO TO CITATION(S) 6566*

6505 **(CONF-860786—1) Quality Assurance requirements - Safety Analysis Reports for Packaging. An effective approach in developing QA requirements.** Fabian, R.R. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001507.

From Health and safety conference; Albuquerque, NM, USA (15 Jul 1986).

Application of QA requirements for packaging and transportation of radioactive materials should not be solely based on safety-related considerations. The operability of items, components, and systems must be considered as equally important. The nuclear industry has begun to recognize operability considerations along with safety concerns. This has resulted in a new approach in establishing QA requirements for packaging.

## 0510 Marketing, Economics, And By-products

**6506 Electric demand growth: An uncertain future for uranium.** Asbury, J.G. Littleton, CO; Society of Mining Engineers of AIME (1985). 7p. (CONF-851054—). Society of Mining Engineers of AIME, Caller No. D, Littleton, CO 80127.

From Society of Mining Engineers fall meeting; Albuquerque, NM, USA (16 Oct 1985).

Broadly conceived, the demand for electricity depends upon three sets of variables: (i) the growths of the many individual demands for energy services; (ii) the competitiveness of electrically driven technologies in meeting these demands; and (iii) the energy-conversion efficiencies of installed electrical technologies. The first set of variables establishes the size of the potential market; the second, the market penetration of electrical equipment; and the third, the quantity of electricity required to operate the equipment. All forecasts of electricity consumption ultimately depend upon inferred or assumed relationships to describe the future behavior of these variables. In this paper, the authors review recent forecasts of electricity demand growth. They also examine, in a qualitative way, some of the causes for the systematic, downward revisions of these forecasts over recent years. Graphical presentations of data are extensively used in the discussions. In an important sense, forecasting, whatever the number of variables, remains a matter of "curve fitting."

## 0520 Waste Management

*REFER ALSO TO CITATION(S) 6493, 6572, 6573, 6575, 6827, 6885*

**6507 (CONF-860990—7) Impacts of hazardous waste regulation on low-level waste management.** Sharples, F.E.; Eyman, L.D. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001824.

From 8. annual participants' information meeting of the DOE Low-Level Waste Management Program; Denver, CO, USA (22 Sep 1986).

The Hazardous and Solid Waste Amendments of 1984 have greatly expanded the universe of what, and who, is regulated under Resource Conservation and Recovery Act (RCRA). Handling requirements for hazardous waste are becoming increasingly more stringent, particularly where land disposal is concerned. DOE needs to begin actively pursuing strategies directed at keeping the management of LLW clearly separated from wastes that are legitimately regulated under RCRA. Such strategies would include instituting systemwide changes in internal management practices, establishing improved location standards for LLW disposal, and negotiating interagency compromise agreements to obtain variances from RCRA requirements where necessary and appropriate.

**6508 (CONF-860990—8) ADGEN: a system for automated sensitivity analysis of predictive models.** Pin, F.G.; Horwedel, J.E.; Oblow, E.M.; Lucius, J.L. (Oak Ridge National Lab., TN (USA)). Sep 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002186.

From 8. annual participants' information meeting of the DOE Low-Level Waste Management Program; Denver, CO, USA (22 Sep 1986).

A system that can automatically enhance computer codes with a sensitivity calculation capability is presented. With this new system, named ADGEN, rapid and cost-effective calculation of sensitivities can be performed in any FORTRAN code for all input data or parameters. The resulting sensitivities can be used in performance assessment studies related to licensing or interactions with the public to systematically and quantitatively prove the relative importance of each of the system parameters in calculating the final performance results. A general procedure calling for the systematic use of sensitivities in assessment studies is presented. The procedure can be used in modelling and model validation studies to avoid "over modelling," in site characterization planning to avoid "over collection of data," and in performance assessment to determine the uncertainties on the final calculated results. The added capability to formally perform the inverse problem, i.e., to determine the input data or parameters on which to focus additional research or analysis effort in order to improve the uncertainty of the final results, is also discussed.

**6509 (DOE/AL/10752—35) Stable isotopes in southeastern New Mexico groundwater: Implications for dating recharge in the WIPP [Waste Isolation Plant] area.** Chapman, J.B. (New Mexico Health and Environment Dept., Santa Fe (USA). Environmental Improvement Div.). Oct 1986. Contract AC04-78AL10752. 92p. (EEG—35). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87002504.

The first geologic repository for nuclear waste in the United States, the Waste Isolation Pilot Plant (WIPP), is being excavated at a depth of 2150 ft below ground surface in the Salado Formation in southeastern New Mexico. If a breach of the repository occurs, the water-bearing zones of the Rustler Formation, overlying the Salado, are considered to be the most likely pathways for the transport of radionuclides to the biosphere. A thorough characterization of the hydrology of the Rustler Formation is crucial to the evaluation of the consequences of a breach of the WIPP repository. The present study compiles stable isotope data from throughout southeastern New Mexico and compares them to data from the WIPP area. The stable isotopic compositions of most samples of groundwater from the Rustler Formation are similar to the composition of other, verifiably young, groundwater in the area. Though the stable-isotope data cannot indicate ages for water in the various aquifers, neither do the data show any distinction between most Rustler groundwater and verifiably young groundwater.

**6510 (DOE/OR/20722—99-Rev.1) Hazelwood Interim Storage Site: Annual site environment report, Calendar year 1985.** (Bechtel National, Inc., Oak Ridge, TN (USA)). Nov 1986. Contract AC05-81OR20722. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002727.

The Hazelwood Interim Storage Site (HISS) is presently used for the storage of low-level radioactively contaminated soils. Monitoring results show that the HISS is in compliance with DOE Derived Concentration Guides (DCGs) and radiation protection standards. During 1985, annual average radon concentrations ranged from 10 to 23% of the DCG. The highest external dose rate at the HISS was 287 mrem/yr. The measured background dose rate for the HISS area is 99 mrem/yr. The highest average annual concentration of uranium in surface water monitored in the vicinity of the HISS was 0.7% of the DOE DCG; for $^{226}$Ra it was 0.3% of the applicable DCG, and for $^{230}$Th it was 1.7%. In groundwater, the highest annual average concentration of uranium was 12% of the DCG; for $^{226}$Ra it was 3.6% of the applicable DCG, and for $^{230}$Th it was 1.8%. While there are no concentration guides for stream sediments, the highest concentration of total uranium was 19 pCi/g, the highest concentration of $^{226}$Ra was 4 pCi/g, and the highest concentration of $^{230}$Th was 300 pCi/g. Radon concentrations, external gamma dose rates, and radionuclide concentrations in groundwater at the site were lower than those measured in 1984; radionuclide concentrations in surface water were roughly equivalent to 1984 levels. For sediments, a meaningful comparison with 1984 concentrations cannot be made since samples were obtained at only two locations and were only analyzed for $^{230}$Th. The calculated radiation dose to the maximally exposed individual at the HISS, considering several exposure pathways, was 5.4 mrem, which is 5% of the radiation protection standard.

**6511 (DPST—84-507) Extended ion exchange process for removal and recovery of technetium from soluble waste.** Bibler, J.P.; Wallace, R.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 22 May 1984. Contract AC09-76SR00001. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002662.

A well-established method of separation of $^{99}$Tc from soluble waste is sorption of pertechnetate ion, $TcO_4^-$, onto a strong base anion exchange resin such as Dowex 1x8. Pertechnetate ion can then be removed from the resin by elution with 4M $HNO_3$. An improved ion exchange method which encompasses removal and recovery of $^{99}$Tc from defense waste supernate has been demonstrated. The introduction of a second ion exchange step using a

weak base resin allows for the reclamation and recycling of large volumes of nitric acid generated in the initial collection of $TcO_4^-$ on the strong base resin. Also, the total amount of waste $NaNO_3$ which is added to the system in the process of removing $^{99}Tc$ from the supernate is significantly reduced from 8% to 1%. $^{99}Tc$ can be recovered from solution by precipitation as $Tc_2S_7$ with sulfide or as $TcO_2$ following reduction with aluminum or zinc amalgam, affording the ultimate recovery of the pure metal.

6512 (LBL—21850, pp 1-3) **Coupled processes in NRC HLW research.** Costanzi, F.A. (Nuclear Regulatory Commission). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Research efforts in coupled processes in high-level radioactive waste disposal are described. These efforts are focused on materials and engineering, hydrology and geochemistry, compliance assessment and modeling, behavior of a repository under off-normal conditions, formation of validation models, natural analogs to validate predictions, and peer review of science used in developing the technical basis for repository licensing. The objectives and activities in the programs are presented.

6513 (LBL—21850, pp 4-5) **Implementation of the Nuclear Waste Policy Act of 1982.** Klingsberg, C. (Dept. of Energy, Washington, DC). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

A major milestone in the nation's management of nuclear waste was met when the President signed the Nuclear Waste Policy Act (NWPA) into law on January 7, 1983. The NWPA established a national policy for safely storing, transporting, and disposing of spent nuclear fuel and high-level waste. Under the Act, the US Department of Energy (DOE) has the primary responsibility to: perform research and development, and demonstrate the disposal of spent fuel and high-level waste; and design, schedule, site, construct, and operate deep-mined geologic waste repositories. The NWPA authorizes a number of activities which, taken together, can meet the objectives of providing safe and permanent disposal of spent fuel and high-level waste. These activities are discussed.

6514 (LBL—21850, pp 6-7) **Opening presentation by the OECD Nuclear Energy Agency to the International Symposium on Coupled Processes affecting the performance of a nuclear waste repository.** Carlyle, S.G. Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The activities of the OECD Nuclear Energy Agency are described. The work covers three main activities: (1) the consideration of progress of NEA projects that fall under the heading of geological disposal; (2) organizing workshops to address topical issues; and workshops to address topical issues; and (3) provision of a forum for the exchange of scientific information arising from national research programs in OECD Member countries. The scope of these activities cover two general headings: (a) the development of performance assessment methodologies and (b) the acquisition of field and laboratory data. These activities are discussed.

6515 (LBL—21850, pp 8-9) **Outline of some European Community activities on coupled processes.** Venet, P.F. (Commission of the European Communities, Brussels, Belgium). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Some of the European Community activities in the field of coupled processes linked with radioactive waste geological disposal are discussed. This is an example of what can be realized at the international level.

6516 (LBL—21850, pp 10-19) **Basalt waste isolation project overview.** Dahlem, D.H. (Dept. of Energy, Richland, WA). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The proposed candidate basalt site for high-level nuclear waste repository is located beneath the Hanford Nuclear Reservation in southeastern Washington State. At this point, the Hanford Reservation has been selected as one of three preferred candidates in the draft Environmental Assessment. Project activities have concentrated on (1) understanding the site location with respect to the 10CFR60, 40CFR191, and 10CFR960, (2) identifying critical parameters for design of waste package and repository seals, and (3) identifying parameters for repository design. The program to evaluate the site and identify the natural processes that would effect isolation is described.

6517 (LBL—21850, pp 20-28) **Coupled processes addressed by underground testing for the Salt Repository Project.** Kalia, H.; Roberds, W.J.; Byrne, R.J. (Battelle Pacific Northwest Lab., Columbus, OH). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

As part of the licensing process, various aspects of performance of a repository system must be assessed in order to demonstrate compliance with the pertinent federal regulations (e.g., 10CFR60, 40CFR1919, etc.). Such performance will be a function of the site characteristics and the design variables, i.e., the system parameters. The relevant system parameters derive from a consideration of the processes taking place within the system. These processes can be categorized as thermal, mechanical, hydrological, and chemical, or as combinations of these. Uncertainties in the understanding of the processes, in their representation by models, and in the system parameters lead to uncertainties in performance prediction. The basic objective of underground testing, as well as other testing, is to sufficiently reduce these uncertainties. A tentative set of information needs, which derives from current uncertainties in both the relevant system parameters and the modeling of processes (coupled and uncoupled), has been developed for the Salt Repository Project (SRP). A program of underground testing to be conducted in an Exploratory Shaft Facility (ESF) was developed to satisfy, in conjunction with other test programs, these (SRP) information needs. This activity is discussed with emphasis on coupled processes.

6518 (LBL—21850, pp 29-36) **Experiments performed on granite in the Underground Research Laboratory at Fanay-Augeres, France.** Barbreau, A.; Come, B.; Derlich, S.; Durand, E.; de Marsily, G.; Peaudecerf, P.; Vouille, G. (CEA, Institut de Protection et de Surete Nucleaire, Fontenay-Aux-Roses, France). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

An underground research laboratory has been developed in a granite formation in order to improve the knowledge of the properties and behavior of the fractured medium. Two main programs are at present underway in this laboratory: the study of the influence of the scale effect on the measured value of the permeability and dispersion coefficients, and an hydro-thermo-mechanical experiment. A review of the preliminary results of the first experiment is presented and the second one which is now being initiated is described.

6519 (LBL—21850, pp 37-45) **Recent progress of the NEA Stripa Project on in situ experiments in granite associated with the disposal of radioactive wastes.** Carlyle, S.G.; Carlsson, H. (OECD/NEA, Paris, France). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The NEA Strip Project has devoted considerable effort to the measurement and assessment of the hydrogeology, hydrogeochemistry and migration phenomena of the stripa granite and to the simulation of conditions likely to be found within an engineered repository in granitic rock. These include (1) the refinement of existing and the development of new, geophysical and hydraulic techniques for the mapping and characterization of fractures in crystalline rocks; (2) conducting field experiments to assess the migration of tracers in single and multiple fracture systems; and (3) studying the behavior of bentonite clay as a backfilling and sealing material in a granitic environment. The results and conclusions from Phase 1 of the project, and early results from Phase 2, were presented at a Symposium held in Stockholm, Sweden, in June 1985. The most important findings are summarized and the main aims of possible future research under any Phase 3 of the project are outlined. The latter may well include making mathematical productions of the hydrogeological behavior of the strip granite and their subsequent validation by field measurements.

6520 (LBL—21850, pp 46-49) **Overview of some geotechnical experiments within the Canadian Nuclear Fuel Waste Management Program.** Dormuth, K.W. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Within the Canadian Nuclear Fuel Waste Management Program, extensive geotechnical experimentation is being carried out on processes of significance to the safe disposal of nuclear fuel waste in fractured plutonic rock. Examples of experiments conducted in the program illustrate the relationship between mathematical models and field information.

6521 (LBL—21850, pp 50-57) **Geological disposal in the Belgian context.** Heremans, R.H.; Baetsle, L.H. (ONDRAF/NIRAS Brussels, Belgium). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The way of studying the high-level and $\alpha$-bearing waste burial problem can vary from one country to another. In Belgium, if the electronuclear power represents about 60% of the total electricity production, the installed capacity is however limited to 5500 MWe. Furthermore, Belgium is a small country, densely populated, and its geology does not allow a large choice of underground formations acceptable for safe waste disposal. In 1974, site specific investigations were started on a 700 hectares area in the NE part of the country where Belgium's main nuclear research center and some nuclear fuel cycle facilities are located. The formation considered is a tertiary age clay layer underlying the Mol-Dessel area. Study and research works were organized in the frame of successive five year programs. The main objectives of the research are presented. After 10 years of intensive field, laboratory and desk work the obtained results allowed to start of the drafting of Preliminary Safety and Feasibility report in view of the construction of a demonstration facility. The project was performed by the CEN/SCK in the frame of shared financing contracts with the CEC and ONDRAF/NIRAS.

6522 (LBL—21850, pp 58-67) **Swiss field investigations for radioactive waste repositories.** McCombie, C.; Nold, A.L.; Thury, M. (National Cooperative for the Storage of Radioactive Waste (Nagra), Baden, Switzerland). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The Swiss National Cooperative for the Storage of Radioactive Waste, Nagra, plans two types of repositories, one for high level waste and possibly certain alpha-containing intermediate level wastes (Type C repository) and one for low and intermediate level wastes (Type B repository). For the Type C repository, a regional field investigation program was started in 1980 with geophysical, hydrogeological and neotectonic investigations and a deep drilling program, in which to date 6 deep boreholes of a total length of more than 10 km have been drilled and investigated. For the Type B repository, preliminary field investigations have been carried out at 20 potential sits and a detailed to site investigation program at 3 sites is ready to start as soon as the needed permits from the authorities are granted. At Grimsel, an underground test facility (FLG) has been excavated and several test programs are in progress.

6523 (LBL—21850, pp 68-72) **Overview of coupled processes with emphasis in geohydrology.** de Marsily, G. (Ecole des Mines de Paris, Fontainebleau, France). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

In the underground, fluids are always present; most of the time, water is saturating the medium, but in some cases unsaturated media can be found even at great depth. These fluids are in general moving because of pressure gradients imposed by a complex function of the topography and of infiltration (thus of the climate). The outlets of these movements are generally very localized (e.g. streams, springs) because again of topographical effects and/or of natural discontinuities which act as drains of the system. The fluid velocity and pathways in the underground are governed by the distribution of the hydraulic conductivity throughout the system, from the recharge zones to the outlets. This general circulation is in most cases slow enough for the water to reach equilibrium (or pseudo-equilibrium) with each of the successive types of rocks along its flow path at their respective pressure and temperature. These successive equilibriums mean changes in chemical composition of the water, thus reactions with the medium (precipitation, dissolution, etc...) which in turn modify the hydraulic conductivity and flow path. Natural geodynamic processes (e.g. stress distribution variations, tectonic activity) on the other hand also modify the hydraulic conductivity and the flow path. These processes are reviewed, and the similar coupled processes which can be observed in nature are mentioned.

6524 (LBL—21850, pp 73-82) **Coupled processes in geomechanics.** Cook, N.G.W. (Univ. of California, Berkeley). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The safe operation of an underground repository for the disposal of nuclear wastes and the isolation of these wastes from the accessible environment, may be affected adversely by the formation of new fractures in the rock close to these excavations or by movements across pre-existing fractures. Both phenomena may so enhance the permeability of the rock as to allow possibly contaminated groundwater to reach the accessible environment. For hard rocks, the formation of new fractures in the regions of high stress concentration adjacent to excavations is analyzed in terms of breakouts or spalling. In rocksalt, creep may allow the stress adjacent to excavations to decrease below the hydrostatic pressure so that hydraulic fractures may form, or the extension of layers other than salt may produce new hydraulic conduits. The deformation of fractures in response to changes in stress pore pressure, and temperature are analyzed for pre-existing fractures, as is also the shear stability of the fractures. Experience and in situ testing are seen to be of the greatest importance in identifying and understanding coupled phenomenon in geomechanics.

6525 (LBL—21850, pp 83-88) **Coupling of fluid flow with step-wise alteration of glass waste forms.** Apted, M.J.; Lane, D.L.; Allen, C.C.; Adee, R.R.; Rawson, S.A. (Pacific Northwest Labs., Richland, WA). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The effect of flow of a basalt groundwater on the alteration of a borosilicate glass at 150°C was investigated. The first observable effect is that glass dissolution rates increased appreciably with increasing flow rate. Such effects promote a more rapid alteration of glass to solids that will initially control the release rate of many radionuclides. The second effect is that solution supersaturations are progressively suppressed with increasing flow rate. Under favorable circumstances, this could prevent the formation of some metastable alteration solids and promote the formation of more stable solids and promote the formation of more stable solids. In this way, the progressive step-wise alteration of glass could be studied, and an evaluation made of the long-term controls for radionuclide release from glass waste forms. Failure to demonstrate such step-wise alteration in these preliminary flow tests may be attributable to high initial solution supersaturations developed from non-flow-related factors or to diffusional constraints to continued chemical reaction processes at the glass surface.

6526 (LBL—21850, pp 89-90) **Assessment of the combined effects of temperature increase, water convection, migration of radionuclides and radiolysis on the safety of a nuclear waste repository in the boom clay.** Baetsle, L.H.; Bonne, A.; Henrion, P.; Put, M.; Patyn, J. (SCK/CEN, Mol, Belgium). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

For a potential repository in the boom clay formation 220 M beneath the nuclear research center at Mol, Belgium, extensive temperature calculations have been done for several repository configurations. Taking into account, near field and far field temperature limitations, an acceptable heat load of 2.5 $W/m^2$, and a cooling time of 50 years have been derived. A qualitative discussion is given of the impact of a temperature increase on the migration pattern and on the global effect as a function of disposal periods. Hydrological phenomena in the water tables surrounding the boom clay layer were studied by installing a piezometric observation network over a surface of 2500 $km^2$. A mathematical model was developed to interpret the piezometric observations and to derive the regional flow pattern and the water transfer through the low impermeability clay layer. These results were verified by dating of the groundwaters and the interstitial clay water.

6527 (LBL—21850, pp 91-96) **Coupled processes at the Oklo Natural Reactor.** Brookins, D.G. (Univ. of New Mexico, Albuquerque). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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The Oklo Natural Reactor, Gabon, is an excellent site in which to study, assess and evaluate coupled processes of interest to radionuclide migration in natural media. The uranium accumulations in which the fission reactions occurred are dated at about two Gy (billions of years), and the nuclear reactions lasted for some 500,000 y (+/-). Temperatures in the reactor zones were on the order of 300 - 450°C, although local, higher temperatures may have been reached. This thermal regime aided in the diffusion of some fission products, and possibly actinides, from host pitchblende. Post-reactor diagenesis events have masked some of the radionuclide migration paths, but most can still be studied. The combined thermal and geochemical aspects of Oklo allow estimates of degree of radionuclide migration to be estimated, and aspects of both near-field and far-field behavior can be evaluated from combined theoretical and experimental studies. After some twelve years research, it appears that most of the Oklo fission products and actinides did not migrate any appreciable distance from the host pitchblende, and that the rocks at the Oklo site are adequate to fix migrating radionuclides in them.

6528 (LBL—21850, pp 97-102) **Effects of geochemical processes on the transport of contaminants in multicomponent systems: a modeling perspective.** Cederberg, G.A. (Los Alamos National Lab., NM). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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An equilibrium geochemical transport model for multicomponent systems, TRANQL, was used to investigate the effects of geochemical processes on the transport of contaminants. TRANQL was used to investigate the sensitivity of cadmium transport to a range of initial conditions, pH, complexing ligand concentrations, and concentrations of a simultaneously sorbing solute. Aqueous-phase complexation, dissociation of water, and sorption were the processes considered. First, the transport of a initial pulse of cadmium with a constant concentration of EDTA was examined. Second, the transport of an initial pulse of cadmium and EDTA was simulated. The effects of variations in EDTA concentrations and pH were investigated. Finally, the transport of an initial pulse of cadmium and cobalt was examined. Results show a significant coupling between the geochemical processes of complexation and sorption and mass-transport. In cases where sorption is considered to be an important controlling reaction the transport of a solute in multicomponent systems is a strong function of the initial concentration and distribution of complexing ligands, pH, equilibrium formation constants, and the concentration of a simultaneously sorbing solute.

6529 (LBL—21850, pp 103-108) **Nuclide transport, precipitation, dissolution and shared solubility limits.** Hopkirk, R.J.; Gilby, D.J. (Polydynamics Ltd., Zurich, Switzerland). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Most of the actinides and many of the fission and activation products in high level nuclear waste are soluble in some groundwaters only to a very limited extent. In addition, the solubility capacity for certain elements is shared amongst capacity for certain elements is shared amongst several isotopes. This becomes critical when dealing with the members of the actinide decay chains. Solubility limitations and transport rates are strongly coupled for all the important isotopes. An iterative dynamic relaxation method has been developed in order to allow the simultaneous treatment of this coupled problem for the members of the actinide decay chains within the framework of an implicit finite difference code (TROUGH). The code has been used to study the diffusive release of radionuclides from the near field of a repository for reprocessed high level waste where a reducing groundwater is expected. A simple relationship for establishing the instantaneous, local level of solubility for each isotope has been employed. Solubility limitation in conjunction with the sorption capacity of the clay backfill in the repository storage tunnels results in many nuclides decaying to insignificant activity levels before release to the geosphere.

6530 (LBL—21850, pp 109-113) **Role of uranium series disequilibrium studies of fluids and solids in geological systems with potential for radioactive waste disposal (H-C).** Ivanovich, M. (Atomic Energy Research Establishment, Harwell, England). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Uranium series radionuclides provide one of the most sensitive natural isotopic signatures in groundwater studies and as such have been used successfully to identify water masses and to evaluate quantitatively the mixing of waters on a regional scale. An example of such an application is a recently completed study of a multilithological system in the Harwell region. The principal aim of the program was to establish the groundwater flow patterns using hydrogeological and geochemical methods in association with isotope contents and uranium series disequilibrium and thus provide an independent approach to the study of effective permeabilities of clay lithologies in a sedimentary sequence. The uranium isotopic

signatures in groundwater samples collected from the region have been interpreted in terms of the regional groundwater circulation and mixing, and the most significant zones of groundwater movement through clay lithologies have been identified. A complementary approach is to measure isotopic signatures in various phases of the solid matrix. This latter approach is illustrated by a recent study of the distribution of the longer-lived radionuclides $^{238}U$, $^{234}U$, $^{230}Th$, $^{232}Th$ and $^{228}Th$ between the pore water, iron oxyhydroxides and clay mineral phases in a thick surface deposit at Elstow, England.

6531 (LBL—21850, pp 114-119) **Electrolyte diffusion in compacted montmorillonite engineered barriers.** Jahnke, F.M.; Radke, C.J. (Univ. of California, Berkeley). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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The bentonite-based engineered barrier or packing is a proposed component of several designs conceived to dispose of high-level nuclear waste in geologic repositories. Once radionuclides escape the waste package, they must first diffuse through the highly impermeable clay-rich barrier before they reach the host repository. To determine the effectiveness of the packing as a sorption barrier in the transient release period and as a mass-transfer barrier in the steady release period over the geologic time scales involved in nuclear waste disposal, a fundamental understanding of the diffusion of electrolytes in compacted clays is required. A model quantifying the diffusion rates of cationic cesium and uncharged tritium in compacted montmorillonite clay is presented. Neutral tritium characterizes the geometry (i.e., tortuosity) of the particulate gel. After accounting for cation exchange, the authors find that surface diffusion is the dominant mechanism of cation transport, with an approximate surface diffusion coefficient of $2 \times 10^{-6}$ cm$^2$/s for cesium. This value increases slightly with increasing background ionic strength. The implications of this work for the packing as a migration barrier are discussed.

6532 (LBL—21850, pp 120-124) **Steady radionuclide release rates from a bentonite-protected waste canister.** Jensen, D.J.; Radke, C.J. (Univ. of California, Berkeley). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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A bentonite-based packing or engineered barrier is one ingredient of the multibarrier concept for underground storage of high-level nuclear waste. The possible effectiveness that such a smectite-laden barrier might have in controlling steady, solubility-limited release rates from a cylindrical waste canister was studied. Darcy's law and the convective-diffusion equation in two dimensions were solved numerically with and without an annulus of packing material. Reduced fractional release rates quantifying the role of the packing were studied over wide ranges of ground water velocities, packing amounts, and packing permeability and effective diffusivity. Release rates are shown to be strongly dependent on the physical properties of the packing, particularly the effective diffusivity. Although the low permeability of a bentonite-rich packing negates convection next to the canister, calculated release rates of the packing-protected waste canister do not differ dramatically from those for the unprotected canister, except at high ground water velocities. To afford more protection, consideration must be given to reducing the porosity of the packing material.

6533 (LBL—21850, pp 125-131) **Principle of a code computing the migration of ions with precipitate.** Mangin, J.P.; Hoan, N.N. (Centre d'Etudes Nucleaires, Fontenay-Aux-Roses, France). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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A computational method is presented that describes the migration of the ions in porous rocks. For the description of the migration, due to convection and Fick diffusion the creation and annihilation of the precipitate were studied. The separation between regions with and without precipitate is evolving in time, but the meshes are fixed.

6534 (LBL—21850, pp 132-137) **Coupled approach to radioelement migration modelling in United Kingdom.** Read, D.; Williams, D.R.; Liew, S.K. (UWIST, Cardiff, England). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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At present, the United Kingdom Department of the Environment is applying a series of computer models based on the AECL SYVAC code to assess the radiological impact of low to intermediate - level waste disposal under conditions appropriate to the UK. As detailed representation of chemistry is not an integral part of these models, output needs to be cross verified by comparison to coupled geochemical-hydrologic codes. A coupled approach involving the chemical transport simulator, CHEMTRN, in conjunction with the mass transfer program, PHREEQE is described. In the sense that CHEMTRN is itself a stand-alone direct approach to coupling, the procedure is a combination of direct and iteratively coupled geochemical-hydrologic modelling but one in which the chemistry of the system is monitored throughout. The results of independent verification studies are summarized and recommendations are made regarding the potential role of CHEMTRN in radiological assessment. Case studies on a prospective UK site are described. They emphasize the importance of including the effects of aqueous complexation on sorption processes when modelling the migration of radioelements from a disposal vault to the surface.

6535 (LBL—21850, pp 138-139) **Effect of ionizing radiation on waste package performance in a basalt high level waste repository.** Reed, D.T. Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Current data are presented on the effect of ionizing radiation on the performance of the waste package in the proposed high level waste repository in the Columbia River basalts. The potential of ionizing radiation to alter chemical and geochemical processes has been well established. The primary mechanism is the formation of radiolytic species which will affect the transport of radionuclides, their speciation, the stability of the packing and container corrosion. These effects are not additive and must be integrated into the performance models developed for the waste package. Ionizing radiation will have the most impact on the performance of the waste package since radiation levels are highest there. The coupling of radiolytic processes with geochemical/chemical processes in basalt groundwater/packing waste form systems is being investigated as part of an ongoing effort in the Basalt Waste Isolation Project (BWIP). Of primary concern are the effect of radiation on the composition of the groundwater, redox environment, packing alteration, pH and formation of organic polymers.

6536 (LBL—21850, pp 140-145) **Development of an algorithm for the biochemical evolution of uranium mill tailings.** Snodgrass, W.J.; Nicholson, R.V.; Garisto, N.C. (Beak Consultants Ltd., Mississauga, Ontario). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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An analysis of relevant time scales for modelling the geochemical evolution of uranium mill tailings (seconds to millions of years) is presented. It is suggested that the chemical retention time of pore water is an appropriate parameter for assessing the interaction of transport and kinetics in formulating an algorithm for the evolution of uranium mill tailings. Two special sub-studies are presented. In one, a reaction-transport model is used to examine the sensitivity of pyrite oxidation to kinetics and transport in the unsaturated zone. The results suggest that the oxygen flux (acid production flux) from a column of tailings is most sensitive to the dif-

fusion coefficient and relatively insensitive to the pyrite oxidation rate constant. This suggests priorities for research (measurement of diffusion coefficient) and management strategies (low diffusion cover). In a second study, reaction code pathway calculations of an equilibrium mineral assemblage for Fe-Ca-Al-S-$CO_2$-$H_2O$ are made. The evolution of minerals along an oxygen-added reaction pathway is quite sensitive to the initial ratio of goethite and pyrite present. A comparison with available field data suggests that the model simulates the expected trend of pH, but that the simulated trend of pe is in error. This uncertainty may result from the presence of pseudo-stable phases or the lack of equilibrium with pyrite. An approach for coupling these processes is to titrate an equilibrium mineral assemblage with pyrite oxidation products and use results from the reaction-diffusion model to ascribe a time dimension to the reaction pathway.

6537 (LBL—21850, pp 146-148) **Chemical and diffusional effects in a thermal gradient: results of recent experimental studies and implications for subseabed disposal of nuclear waste.** Thornton, E.C.; Seyfried, W.E. Jr. (Univ. of Minnesota, Minneapolis). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Solute transport in response to a thermal gradient (thermal diffusion or the Soret effect) is likely to be an important consideration in the disposal of nuclear waste in low-permeability, fluid-saturated media. Thus, thermal gradient experiments and a large-scale heat transfer experiment were conducted with marine clay and inert matrices to assess Soret diffusion and rock alteration effects. These data are particularly applicable to the subseabed disposal concept, but provide a basis as well for assessing mass transport phenomena for clay backfill materials.

6538 (LBL—21850, pp 149-161) **Flow and tracer experiments in crystalline rocks. Results from several Swedish in situ experiments.** Abelin, H.; Birgersson, L.; Gidlund, J.; Moreno, L.; Neretnieks, I.; Tunbrant, S. (Royal Institute of Technology, Stockholm, Sweden). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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In a final repository for radioactive waste in crystalline rock, water flowing in the fractures may transport the radionuclides eventually leached from the waste. To be able to predict the migration of the radionuclides the processes involved must be understood. To quantify the processes, data from flow and transport in real fractures under realistic conditions are needed. Models used for prediction must include descriptions of the important processes and mechanisms. Most previous studies concerning water flow in rocks are based on the assumption that the water flow can be described as porous media flow. This might be true for very large distances where the flow would encounter a multitude of fractures, and some averaging may be conceivable at the scale considered. The migration modelling in the safety analysis for a repository in granitic rock is based on the assumption that if and when any radionuclides are leached from the waste, practically all of the important radionuclides will interact chemically or physically with the bedrock and will thereby be considerably retarded. The magnitude of this retardation depends upon the flow rate of the water, the uptake rates and equilibria of the reactions as well as the surface area in contact with the flowing water.

6539 (LBL—21850, pp 162-167) **Hydrology and chemistry of Hosokura Tuff in Japan.** Araya, S.; Mishima, T.; Maekawa, K.; Asano, T.; Saito, S.; Ueta, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo, Japan). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Various kinds of in-situ tests have been conducted on the Hosokura Tuff in Japan. Several results on hydrological and chemical tests are presented. The permeability tests were carried out by the rock mass, 3 m diameter and 4 m long, and the value of 1.2 x $10^{-12}$ m/s was determined. In the in-situ migration test, the water contained four stable elements (Co, Sr, Cs, and I) was pumped down into a injection hole, and the test results implied the retardation factors of Co, Sr, and Cs being about 70, 70, and 110, respectively.

6540 (LBL—21850, pp 168-169) **Hydraulic and ionic diffusion properties of bentonite/sand buffer materials.** Cheung, S.C.H.; Gray, M.N. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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The Canadian Nuclear Fuel Waste Management Program is assessing the concept of safe disposal of nuclear fuel waste in a vault mined deep in plutonic rock. Groundwater, which will penetrate to the waste, has the potential to leach out radionuclides and transport them to the surface. A number of protective barriers will minimize the rate at which this will occur: these include a corrosion-resistant container, buffer and backfill materials and the surrounding rock. The buffer material is likely to be a compacted mixture of bentonite and sand. A knowledge of the rate of radionuclide transport through the buffer is required as input for the safety assessment of the disposal concept. A model based on the relative volumes of surface and interstitial water in bentonite/sand mixtures was developed to describe the diffusion coefficient. The model assumes that the rate of ionic diffusion in surface water is low compared with that in interstitial water and can be neglected.

6541 (LBL—21850, pp 170-175) **Coupled hydrothermal flows of liquid and vapor in welded tuff: numerical modeling of proposed experiment.** Eaton, R.R.; Bixler, N.E.; Reda, D.C. (Sandia National Labs., Albuquerque, NM). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Pretest calculations of a proposed small-scale, heat-pipe experiment have been made using a finite element, multiphase flow, computer code. The purpose of the experiment is to characterize the response of partially saturated, welded, volcanic tuff to the two-phase countercurrent flow induced by an applied temperature gradient. The experimental measurements will be used to refine the presumed permeability and capillary pressure functions, which are used in the finite element analysis. The calculations presented in this paper, using the presumed material functions, show that saturation profiles and experimental time scales are sensitive to applied temperature gradients and initial liquid saturations. The results have been used to predict appropriate experimental parameter ranges.

6542 (LBL—21850, pp 176-181) **Radionuclide transport as vapor in a non-isothermal dual porosity system.** Green, R.T.; Filippone, W.; Evans, D.D. (Univ. of Arizona, Tucson). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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The importance of forced diffusion relative to ordinary diffusion was investigated as to its potential as a transport mechanism of radionuclides near a HLW repository. Two cases are considered: (1) the canister is located in a rock mass and (2) the canister is located in air. Forced diffusion appears insignificant in the first case but potentially important in the second.

6543 (LBL—21850, pp 182-189) **Coupled process analyses for salt repository performance assessment.** Gupta, S.K.; Bloom, S.G.; Monti, A.M.; Raines, G.E. (Battelle Columbus Labs., OH). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Salt sites are being investigated as potential candidates for a deep geologic repository for high-level nuclear waste. To assess the performance of a repository in salt it is necessary to estimate the potential for naturally occurring and/or intrusive fluids to contact the radioactive waste and transport it to the accessible environment. The long-term performance assessment of a salt repository consists of multidisciplinary studies of the coupled physical and chemical interactions in geologic systems involving heat transfer, ground-water hydrology, geomechanics, geochemistry, and radionuclide transport. The coupled process analyses performed or planned to be conducted include coupled thermal, stress, and pressure-induced brine migration; flow, thermal, mechanical, and geomechanical (corrosion and leach rate) analyses for waste package and waste form performance; flow, thermal, and mechanical analyses for shaft seals and near-field performance; flow, thermal, dissolution, and salt creep analyses for borehole scenarios; flow, energy, and solute transport analyses of the groundwater system in the vicinity of site; and coupled analyses of hydrologic, mechanical, geochemical, and radionuclide transport.

6544 (LBL—21850, pp 190-196) **Colloid migration in porous media.** Hunt, J.R.; McDowell-Boyer; Sitar, N. (Univ. of California, Berkeley). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Retention of radionuclides for long periods near waste repositories depends upon multiple barriers, one of which is adsorption to immobile solid surfaces. Since small particles and colloidal matter have high adsorption capacities per unit mass and can be mobile in subsurface flows, colloidal transport of waste components requires analysis. Theories for predicting colloid migration through porous media have been developed in the filtration literature. The applicability of filtration theories for predicting particle and colloid transport. Emphasis is on suspended matter much smaller than pore sizes, where physical and chemical forces control migration rather than size dependent physical straining. In general, experimentally verifiable theories exist for particle filtration by clean media, and a sensitivity analysis is possible on particle and media properties and fluid flow rate. When particle aggregates accumulate within pores, media permeability decreases, resulting in flow field alteration and possible radionuclide isolation. An analysis of the limited experimental data available indicates that present theories cannot predict long-term colloid transport when permeability reduction occurs. The coupling of colloid attachment processes and the hydrologic flow processes requires more extensive laboratory field research than has currently been carried out. An emphasis on the fundamental mechanisms is necessary to enhance long-term predictability.

6545 (LBL—21850, pp 197-202) **Multiparameter testing of permeability by the transient vacuum technique.** Jakubick, A.T.; Klein, R. (Ontario Hydro, Toronto, Canada). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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This method measures media permeability under unsaturated conditions by radial air withdrawal rather than by axial injection of air. Therefore, large-size specimens or entire models of rock or concrete can be tested without leakage and confinement complications. The identical equipment and technique can also be used to measure rock or concrete under in-situ conditions. Using high-sensitivity vacuum transducers and fast data acquisition it was possible to estimate permeability not only from steady-state measurements but also from the late time portion of the pressure recovery curve even at high values of dimensionless storage constants. The transient vacuum evaluation is especially useful under field conditions because it does not require knowledge of drainage area. The technique proved to be a highly responsive fracture indicator. An increase of permeability with decreasing humidity was observed during tests performed under various humidity conditions.

6546 (LBL—21850, pp 203-206) **Postclosure coupled geohydrological process on top of a repository.** Nguyen, V.V. (EWA, Inc., Minneapolis, MN). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Performance assessment of the conceptual design of a nuclear waste repository involves the evaluation of various coupling modes within the basic flow and transport processes. The coupling modes of interest induce the onset of thermohaline currents in the saturated domain on top of the repository. Once this convective pattern is formed, continuous circulation of the bulk fluid may give rise to the multiple steady states of the chemically reactive species in motion. A synthesis of the state-of-the-art knowledge of this problem is presented, an approach to subsequently study the data uncertainty effects on numerical simulation schemes is presented, and the derived results are illustrated with a Basalt Waste Isolation example.

6547 (LBL—21850, pp 207-210) **Hydrodynamic dispersion.** Pryce, M.H.L. (Univ. of British Columbia, Vancouver). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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A dominant mechanism contributing to hydrodynamic dispersion in fluid flow through rocks is variation of travel speeds within the channels carrying the fluid, whether these be interstices between grains, in granular rocks, or cracks in fractured crystalline rocks. The complex interconnections of the channels ensure a mixing of those parts of the fluid which travel more slowly and those which travel faster. On a macroscopic scale this can be treated statistically in terms of the distribution of times taken by a particle of fluid to move from one surface of constant hydraulic potential to another, lower, potential. The distributions in the individual channels are such that very long travel times make a very important contribution. Indeed, while the mean travel time is related to distance by a well-defined transport speed, the mean square is effectively infinite. This results in an asymmetrical plume which differs markedly from a gaussian shape. The distribution of microscopic travel times is related to the distribution of apertures in the interstices, or in the microcracks, which in turn are affected in a complex way by the stresses acting on the rock matrix.

6548 (LBL—21850, pp 211-216) **Slip-flow experiments in welded tuff; the Knudsen diffusion problem.** Reda, D.C. (Sandia National Labs., Albuquerque, NM). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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Gas-phase permeability experiments, using nitrogen, were conducted on a sample of densely welded tuffaceous material from the Nevada Test Site. The primary independent variable was the average pore pressure, which was systematically varied from 13.1 to 0.1 MPa; net circumferential stress was maintained constant at 4.3 MPa. Gas permeability was found to be a strong function of pore pressure, undergoing an order-of-magnitude increase as pore pressure was reduced over the stated range. Based on these measurements, the Knudsen diffusion coefficient for water vapor, at 296 K, was calculated to be $\approx 3.2 \times 10^{-7}$ m$^3$/s and the material's average pore diameter was estimated to be $\approx 8 \times 10^{-9}$ m. Comparison of this length scale with mercury intrusion porosimetry results showed agreement to within one order of magnitude.

6549 (LBL—21850, pp 217-224) **Theory and application of the PORFLOW model for analysis of coupled flow, heat and radionuclide transport in porous media.** Runchal, A.K. (Analytic & Computational Research, Inc., Los Angeles, CA). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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The theory and application of the PORFLOW model for analysis of coupled flow, heat and species transport processes in saturated, porous or equivalent porous media are discussed. The model is based upon the nodal point integration method. It inherently conserves mass and energy at both local and global scales. It provides for inhomogeneous, anisotropic and time-dependent properties and accounts for buoyancy effects due to density changes. It has been in development for over 9 years and its applications have included nuclear waste disposal, geothermal storage, ground water resource management, chemical pollution of aquifers, and others. Two applications of the model to problems related to disposal of high-level waste are described.

6550 (LBL—21850, pp 225-229) **Analysis of colloid transport.** Travis, B.J.; Nuttall, H.E. (Los Alamos National Lab., NM). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

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The population balance methodology is described and applied to the transport and capture of polydispersed colloids in packed columns. The transient model includes particle growth, capture, convective transport, and dispersion. The multidimensional parabolic partial differential equation was solved by a recently enhanced method of characteristics technique. This computational technique minimized numerical dispersion and is computationally very fast. The FORTRAN 77 code ran on a VAX-780 in less than a minute and also runs on an IBM-AT using the Professional FORTRAN compiler. The packed column experiments by Saltelli et al. were re-analyzed incorporating the experimentally reported size distribution of the colloid feed material. Colloid capture was modeled using a linear size dependent filtration function. The effects of a colloid size dependent filtration factor and various initial colloid size distributions on colloid migration and capture were investigated. The changing colloid size distribution as a function of position in the column was also studied. Some simple arguments are made to assess the likelihood of colloid migration at a potential NTS Yucca Mountain waste disposal site.

6551 (LBL—21850, pp 230-233) **Analysis of permeability reduction during flow of heated, aqueous fluid through Westerly Granite.** Vaughan, P.J. (State Univ. of New York, Plattsburgh). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The permeability of intact granite is known to be controlled by low aspect ratio cracks. A substantial reduction of permeability occurred in experiments in which a heated, aqueous fluid was passed through Westerly Granite down a temperature gradient. Scanning electron microscopy of the sample from this experiment indicated that deposition of material in small cracks (1 μm wide) was the probable cause of the permeability reduction. Much of the deposited material was Si-rich and the fluid discharged from the sample was supersaturated with respect to quartz suggesting that the deposit was quartz. Rate equations for dissolution and precipitation of quartz have been integrated to calculate the concentration of silica in pore fluid moving through the sample. These calculations also predict the concentration of silica in the discharged fluid for comparison with measured values. The comparison indicates that an effective A/M ratio of about 10000 is a reasonable value for Westerly Granite under the conditions of the experiment. The integration of the rate equations also permitted a determination of the volume of quartz dissolved and precipitated in the sample as a function of radius and elapsed time from the start of the experiment. The maximum, calculated decrease in porosity was 8% which would account for about 22% reduction in permeability assuming homogeneous precipitation. However, the observed permeability reduction was 96%. Two possible causes of this discrepancy are; (1) nonhomogeneous precipitation causing a greater rate of permeability reduction, or (2) the precipitation of minerals other than quartz is a contributing factor to the permeability reduction. SEM observations would tend to support either of these possibilities.

6552 (LBL—21850, pp 234) **Effects of silica redistribution on the performance of high-level nuclear waste repositories.** Verma, A.; Pruess, K. Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Evaluation of the thermohydrological conditions near high-level nuclear waste packages is needed for the design of the waste canister and for overall repository design, as well as for performance assessment. Most available studies in this area have assumed that the hydrologic properties of the host rock are not changed in response to the thermal, mechanical, or chemical effects caused by waste emplacement. The dissolution and precipitation of silica in thermally driven flow systems, including changes in formation porosity and permeability were studied. Using numerical simulation, a comparison of the thermohydrological conditions with and without inclusion of silica redistribution effects is presented. Two cases were studied, namely, a canister-scale problem, and a repository-wide thermal convection problem. It was found that silica redistribution can have sizable effects on pore pressures, and on flow velocities. Results showing the sensitivity of those effects to the (hypothetical) pore model of the permeable medium (fractures versus capillary tubes) are presented.

6553 (LBL—21850, pp 235-240) **Coupling of thermoplastic and hydraulic near-field analysis.** Baldi, G.; Borsetto, M.; Hueckel, T.; Peano, A. (ISMES, Bergamo, Italy). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Clay thermomechanical properties were studied experimentally in the range of temperatures to 120° C and of isotropic pressures to 8 MPa. Particularities of water-solid skeleton interaction in heating conditions are pointed out and a novel mathematical model of coupled hydraulic thermo-elastoplastic response is presented. Thermal compaction of clay skeleton both in elastic (overconsolidation) range and in plastic (normal consolidation) range together with significant pore water pressure build up are the principal peculiarities of clay behavior with respect to other geomaterials.

6554 (LBL—21850, pp 241-246) **Modelling of previous fault generation in clay most formation.** Borsetto, M.; Hueckel, T.; Peano, A.; Tassoni, E. (ISMES, Bergamo, Italy). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Some aspects are presented of mathematical simulation of a generation in clay formation of discontinuities propagating from a moving bed-rock. Modelling of pre-critical and post-critical behavior of clay together with discontinuity generation conditions are discussed.

6555 (LBL—21850, pp 247-252) **Coupled processes in repository sealing.** Case, J.B.; Kelsall, P.C. (IT Corp., Albuquerque, NM). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

The significance of coupled processes in repository sealing is evaluated. In most repository designs, shaft seals will be located in areas of relatively low temperature perturbation, in which case the coupling of temperature with stress and permeability may be less significant than the coupling between stress and permeability that occurs during excavation. Constitutive relationships between stress and permeability are reviewed for crystalline rock and rocksalt. These provide a basis for predicting the development of disturbed zones near excavations. Field case histories of the degree of disturbance are presented for two contrasting rock types - Stripa granite and Southeastern New Mexico rocksalt. The results of field investigations in both rock types confirm that hydraulic conductivity or

permeability is stress dependent, and that shaft seal performance may be related to the degree that stresses are perturbed and restored near the seal.

6556 (LBL—21850, pp 253) **Numerical modelling of coupled thermo-hydro-mechanical processes in nuclear fuel waste disposal.** Chan, T.; Guvanasen, V.; Reid, J.A.K. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

A three-dimensional (3D) finite-element code, MOTIF (Model of Transport In Fractured/Porous Media), has been developed to model the coupled processes of groundwater flow, heat transport, brine transport, and one-species radionuclide transport in geological media. Three types of elements are available: (1) a 3D continuum element, (2) a planar fracture element that can be oriented in any arbitrary direction in 3D space, and (3) a line element for simulating fracture flow in 2D space or pipe flow in 3D space. To evaluate the validity of the MOTIF code, it was applied to predict the drawdown and water inflow caused by excavation of the shaft at the Underground Research Laboratory in a granitic pluton on the Canadian Shield. The predictions compared favorably with subsequent field measurements.

6557 (LBL—21850, pp 254-259) **Coupled triaxial testing of rock salt specimens.** Donath, F.A.; Holder, J.T.; Fruth, L.S. (Earth Technology Corp., Long Beach, CA). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

An apparatus is described that permits simultaneous measurement of several coupled geo-mechanical and geophysical parameters on intact specimens of rock salt saturated with brine and subjected to triaxial test conditions. Representative experimental results are presented for hydraulic permeability, electrical resistivity, and p-wave velocity which were determined while the test specimen equilibrated at a confining pressure of 6.2 MPa and a pore pressure of 2.75 MPa, during axial loading and deformation to a total axial strain of 5%, and subsequent to the deformation. The results are cross-correlated with the applied (differential) axial stress. The extremely low permeability of rock salt and corrosive nature of saturated brine required development of special sample preparation and jacketing techniques, as well as wetted apparatus parts made from Hastalloy, and the use of the transient pulse technique for permeability determinations. Measurement of permeability as low as 10 nanodarcy ($10^{-20}$ $m^2$) were successfully made. Measured pore pressure variations caused by either a pressure step increase or decrease showed excellent reproducibility and agreement with calculated curves. During the last 12 hours of equilibration under confining pressure, the permeability of the salt specimen decreased from slightly more than 1 microdarcy to about 500 nanodarcy; permeability increased to approximately 70 microdarcy after deformation to 5% strain.

6558 (LBL—21850, pp 260-267) **Hydromechanical modelling of fractured rock masses using coupled numerical schemes.** Elsworth, D.; Goodman, R.E. (Pennsylvania State Univ., University Park). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Coupled boundary element-finite element procedures are presented for the hydraulic analysis of discretely fractured rock masses. The respective analyses evaluate flow in three dimensional, rigid fractured media in the time domain and two dimensional porous-fractured deformable media. For flow analysis, a direct boundary element procedure is invoked to yield the elemental geometric conductance of an individual fissure disc with reduced degrees of freedom. The global matrices are cast in finite element format and extended to the transient domain. Coupled analysis for deformation utilizes an indirect displacement discontinuity formulation to represent the behavior of the fractured elastic continuum. Flow within both fissures and blocks is achieved using a revised boundary element-finite element procedure. The numerical formulations are illustrated, in all cases, to provide a tractable and computationally efficient means of handling spatially large systems of fractures in either two or three dimensional space. Illustrative examples are included to emphasize the capabilities of the methods presented.

6559 (LBL—21850, pp 271--274) **Shear-flow coupling in non-planar rock joints.** Makurat, A.; Barton, N. (Norwegian Geotechnical Institute, Oslo). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

Crystalline rock masses are regarded as a possible host rock for permanent nuclear waste disposal. During the excavation of the required shafts and tunnels, the initial state of stress will be changed and cause a deformation of the rock mass and discontinuities. During the lifetime of the nuclear repository joint apertures may change due to thermally induced stress variations during the heating and cooling phase. As the conductivity of a joint is very sensitive to its aperture, fluid flow from and towards a repository, as well as the potential transport times of radionuclides are highly dependent on the deformability of the joints. Theoretical calculations of coupled flow in rock joints (Barton et al. 1984) predict an increase of conductivity of several orders of magnitude for the first few millimeters for shear displacement. The shear-dilation-conductivity coupling for two block sizes at two effective stress levels is shown.

6560 (LBL—21850, pp 275-276) **Study of the influence of thermomechanical and hydraulic coupling on radionuclide migration through major fractures.** Millard, A.; Jamet, P.; Durin, M.; Goldstein, S. (CEA Demt. Gif-Sur-Yvette, France). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

In crystalline rock, the performance of nuclear waste repository is strongly dependent upon fractures. A major fracture will lead to a different behavior of rock mass under thermal loading and thus to different values of stress and displacement. Major fractures being preferential ways for ground water flow and thus radionuclide migration, the study of their hydraulic properties versus time with respect to thermal loading was the coupled process studied. The process is described.

6561 (LBL—21850, pp 277) **Coupled hydrological-mechanical effects due to excavation of underground openings in unsaturated fractured rocks.** Montazer, P. (Geological Survey, Denver, CO). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

One of the effects of excavating an underground opening in fractured rocks is a modification of the state of the stress in the rock mass in the vicinity of the opening. This effect causes changes in the geometry of the cross sections of the fracture planes, which in turn results in modification of the hydrologic properties of the fractures of the rock mass. The significance of the orientation of the fractures and their stiffness on the extent of the modification of the hydrologic properties as a result of excavation of underground openings is demonstrated. A conceptual model is presented to illustrate the complexity of the coupled hydrological-mechanical phenomena in the unsaturated zone. This conceptual model is used to develop an investigative program to assess the extent of the effect at a proposed repository site for storing high-level nuclear wastes.

6562 (LBL—21850, pp 278-283) **Development of finite element code for the analysis of coupled thermo-hydro-mechanical behaviors of saturated-unsaturated medium.** Ohnishi, Y.; Shibata, H.; Kobayashi, A. (Kyoto Univ., Japan). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

A model is presented which describes fully coupled thermo-hydro-mechanical behavior of porous geologic medium. The mathematical formulation for the model utilizes the Biot theory for the consolidation and the energy balance equation. The medium is in the condition of saturated-unsaturated flow, then the free surfaces are taken into consideration in the model. The model, incorporated in a finite element numerical procedure, was implemented in a two-dimensional computer code. The code was developed under the assumptions that the medium is poro-elastic and in plane strain condition; water in the ground does not change its phase; heat is transferred by conductive and convective flow. Analytical solutions pertaining to consolidation theory for soils and rocks, thermoelasticity for solids and hydrothermal convection theory provided verification of stress and fluid flow couplings, respectively in the coupled model. Several types of problems are analyzed. The one is a study of some of the effects of completely coupled thermo-hydro-mechanical behavior on the response of a saturated-unsaturated porous rock containing a buried heat source. Excavation of an underground opening which has radioactive wastes at elevated temperatures is modeled and analyzed. The results shows that the coupling phenomena can be estimated at some degree by the numerical procedure. The computer code has a powerful ability to analyze of the repository the complex nature of the repository.

6563 (LBL—21850, pp 284-289) **Field study of coupled mechanical-hydrological processes in fracture crystalline rock.** Sour, L.E.; Richardson, A.M.; Brown, S.M.; Hustrulid, W.A.; Lindner, E.N. (Colorado School of Mines, Golden). Sep 1985. NTIS, PC A14/MF A01 - GPO. File Number TI87000044. (CONF-850981—).

From International symposium on coupled processes affecting the performance of a nuclear waste repository; Berkeley, CA, USA (18 Sep 1985).

A series of experiments with a large in-situ cube of fractured metamorphic rock is heavy conducted. The purpose is to better understand the response of jointed rock to loading. One of the fundamental parameters which can be measured in any mechanical testing scheme is displacement. An instrumentation system was developed to measure absolute displacements in the interior of the block during loading, avoiding a suspected decoupled zone near the surface. The system is based on an array of inductive proximity transducers mounted on a rigid reference frame anchored to the mine roof above the block. The stress field within the block during loading was monitored at several points with U.S.B.M. borehole deformation gages, using elastic moduli determine separately at each point with a borehole dilatometer. With these data the effect of fractures on the redistribution of stresses can be more readily understood. Fracture conductivity affects the rate of contaminant migration from repositories to the biosphere. A multiple-zone borehole probe is being developed that simultaneously monitors fracture aperture and conductivity in each zone. A two-dimensional computer model of the test block is being calibrated with the results of the deformation and stress studies. Successful application of such models would create confidence in using them to predict excavation performance.

6564 **(WINCO—1045) Removable of trace radionuclides and chemical contaminants from waste evaporator condensates by electrodialysis.** Del Debbio, J.A. (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1986. Contract AC07-84ID12435. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002746.

The feasibility of using electrodialysis, a membrane separation process, to remove radioactive and chemical contaminants from Process Equipment Waste (PEW) evaporator condensates was evaluated with a one-hundredth scale vendor-built pilot plant. Decontamination efficiencies (DE) for nine radionuclides and six chemical contaminants were determined. Excluding plutonium, which behaved erratically, the average radionuclide DE was 96%. Nitric acid removal averaged 98%, while the average DE for mercury was 83%. To a large extent, radionuclide removal was due to sorption on the membranes. Seventy-two percent of the input radioactivity for eleven runs became sorbed on the membranes.

6565 **Measurement of radionuclides in waste packages.** Brodzinski, R.L.; Perkins, R.W.; Rieck, H.G.; Wogman, N.A. (to Dept. of Energy, Washington, DC). US Patent 4,617,169. 14 Oct 1986. Filed date 12 Sep 1984. vp.

A method is described for non-destructively assaying the radionuclide content of solid waste in a sealed container comprising: (a) determining the type of reactor responsible for the generation of the waste; (b) determining the degree of fuel enrichment of the reactor; (c) determining the decay time of the waste since exposure in the reactor; (d) measuring the gamma-ray spectrum of the waste; (e) determining the matrix density of the waste from ratios of photopeak pairs from individual radioisotopes in the gamma-ray spectrum; (f) measuring the total neutron flux and the coincidence neutron flux of the waste; and (g) determining neutron multiplicity from the coincidence neutron flux.

6566 **The monitored retrievable storage proposal in the context of the Nuclear Waste Policy Act of 1982.** Cotton, T.A. (Office of Technology Assessment, Congress of the United States, Washington, DC 20510). pp 563-570 of Waste management 86. Volume 2: High-level waste. Post, R.G. Tucson, AZ; University of Arizona (1986). (CONF-860317—).

From Waste management '86; Tucson, AZ, USA (2 Mar 1986).

The Department of Energy plans to submit to Congress a proposal for an integral monitored retrievable storage (MRS) facility located in the eastern United States to serve as the main waste receiving and packaging facility for the geologic repository. This integral role for the MRS is substantially different from the backup storage role previously discussed for Federal storage facilities. The debate over this proposal offers an opportunity for Congress to address and resolve issues that were not dealt with in passage of NWPA, in a way that will enhance the consensus about the waste program. Compared to the no-action option (the authorized system), approval of the integral MRS would probably increase the front-end political and economic costs of developing the waste management system, but could enhance prospects for success and reduce costs in the long run.

6567 **Preliminary estimates of impacts of alternative spent fuel acceptance rates.** Clark, L.L.; McKee, R.W.; Short, S.M. (Pacific Northwest Lab., Richland, WA 99352). pp 583-588 of Waste management 86. Volume 2: High-level waste. Post, R.G. Tucson, AZ; University of Arizona (1986). (CONF-860317—). Contract AC06-76RL01830.

From Waste management '86; Tucson, AZ, USA (2 Mar 1986).

The rate at which spent fuel is accepted by the federal waste management system is an important interface between the private nuclear power sector and the federal government, which will assume responsibility for spent fuel disposal. An analysis of alternative rates based on minimum age criteria indicates substantial incentives to limit acceptance rates so as to result in minimum 10 to 15 year fuel ages for repository acceptance [1500 to 2500 metric tons of uranium (MTU) per year] These incentives include lower heat generation rates and systems costs.

6568 **Interpreting geological structure using kriging.** Mao, N.H. Littleton, CO; Society of Mining Engineers of AIME (1985). 8p. (CONF-851054—). Society of Mining Engineers of AIME, Caller No. D, Littleton, CO 80127. Contract W-7405-ENG-48.

From Society of Mining Engineers fall meeting; Albuquerque, NM, USA (16 Oct 1985).

The authors applied kriging (geostatistics) to interpret the structure of basement rock in Yucca Flat, NTS from borehole data. The estimation error for 118 data is 81 m comparable with those based on both gravity and borehole data. Using digitized topographic data, they tested the kriging results and found that the

model validation process (Thomas option) on data gave a fair representation of the overall uncertainty of the kriged values.

6560 **Actinide and technetium sorption on iron-silicate and dispersed clay colloids.** Shade, J.W.; Ames, L.L.; McGarrah, J.E. (Pacific Northwest Lab., Richland, WA). *ACS Symposium Series;* No. 246, 67-77(1984).

Two different colloidal suspensions, representative of those found in waste package interaction tests, were prepared from iron metal and silica powders or sodium-bentonite at 90°C. Aliquots were spiked with $^{233}U$, $^{236}Np$, $^{237}Pu$, or /sup 95m/Tc at pH ranges from 2 to 12, then shaken for 24 hours followed by a 15 A filtration. Zeta potential measurements were made on unspiked samples. Similar sorptive properties were observed for both colloids. At 25°C both $^{233}U$ and $^{237}Pu$ exhibit maximum sorption (50-90%) near pH 6. Sorption drops by about a factor of 5 at pH > 8. Slight sorption of $^{236}Np$ occurs at pH 11 and decreases to zero at lower pH values. /sup 95m/Tc does not sorb on Fe-silicates and is only slightly sorbed (10%) on smectites. 11 references, 4 figures, 2 tables.

## 0530 Environmental Aspects

*REFER ALSO TO CITATION(S) 6574*

6570 **(PB—86-244936/XAB) Radionuclides: background information document - standard for radon-222 emissions from underground uranium mines.** (Office of Radiation Programs, Washington, DC (USA)). Apr 1985. 157p. (EPA—520/1-85/010). NTIS, PC A08/MF A01.

The report presents background data and other information on underground uranium mining and related emissions of radionuclides, the risks associated with these emissions, and methods for reducing the emissions. Information was complied from the technical literature, previous studies by EPA and the Bureau of Mines, comments received from rule-making notices, and discussions with industry representatives.

6571 **(PB—86-246766/XAB) Transport of anthropogenic radionuclides in the upper sub-basin of the Savannah River. Report for 15 June 1985-30 June 1986.** Fjeld, R.A.; Elzerman, A.W.; Vandeven, J.A. (Clemson Univ., SC (USA). Water Resources Research Inst.). Jun 1986. 81p. (WRRI—122). NTIS, PC A05/MF A01.

The study determines the distribution of major anthropogenic radionuclides in the upper sub-basin of the Savannah River in order to quantify the role of the particulate phase in the transport of Co-60 and Cs-137, and to evaluate a simple compartmental model for predicting H-3 and Cs-137 concentrations in Hartwell Lake. The results showed that reactor releases of H-3, Co-58, Co-60, Cs-134 and Cs-137 were confined to the Seneca River arm of Hartwell Lake. Adsorption was found to be a significant process affecting the transport of cesium radioisotopes. The distribution coefficient for Cs-137 derived from field measurements was approximately 90,000 ml/g.

6572 **Waste package component interactions with Savannah River defense waste glass in a low-magnesium salt brine.** McGrail, B.P. (Battelle Pacific Northwest Labs., Materials Science and Technology Dept., P.O. Box 999, Richland, WA 99352). *Nuclear Technology;* **75**: No. 2, 168-186(Nov 1986). Contract AC06-76RL01830.

Interactive leaching experiments were performed with Savannah River 165 defense waste glass at 90°C in a low-magnesium salt brine (≈100 mg/iota) with various amounts of steel present to simulate interactions between the metal container and the glass. Synergistic interactions occurred between the container material and the glass, which increased the glass dissolution rate. Measured quasi-steady-state solution concentrations of /sup 239/Pu, /sup 237/Np, and /sup 243/Am were reasonably consistent with published solubilities for the respective oxides. Decreasing /sup 238/U concentrations were observed with increasing solution pH, inconsistent with the behavior of uranyl carbonates that presumable predominate at the slightly alkaline pH of the tests. Uranium and plutonium formed pseudocolloids with hematite particles that rapidly formed during the tests. Particle size measurements showed the median size to be >5μm in diameter.

## 0540 Health And Safety

*REFER ALSO TO CITATION(S) 6510*

6573 **(CEA-DPS—85-05) Considerations on the consequences of the variability and uncertainties in the parameters used for assessment of population doses from underground releases of radionuclides.** Robeau, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection Sanitaire). Dec 1985. 25p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750275.

The aim of this report is to assess the variation of the doses usually calculated when the uncertainty affecting each parameter used in the calculation is taken into account. The parameters of a transfer model, i.e. porosity, permeability, fracture coefficient, surface distribution coefficient, hydraulic gradient, transmissivity and dispersivity are studied. The calculations show that the total effect of uncertainties in the various parameters used in modelization can entail variations in the results that must be taken into account imperatively if the results presented are to be meaningful. It is demonstrated that uncertainties in the fracturation and surface distribution coefficients have the largest effects for the generic case investigated.

6574 **(GJ/TMC—01-Ed.2) Field calibration facilities for environmental measurement of radium, thorium, and potassium. Second edition.** Steele, W.D.; George, D.C. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Aug 1986. Contract AC07-76GJ01664. 79p. NTIS, PC A05/MF A01. File Number DE87001841.

A key component of Technical Measurements Center support is the development, identification, standardization, and maintenance of calibration facilities for environmental radioelement measurements. This report describes calibration facilities located at Grand Junction, Colorado, and at six secondary sites. These facilities are available to contractors for the calibration of radiometric field instrumentation for in-situ measurements of radium, thorium, and potassium. All of the calibration facilities described herein were constructed by the Department of Energy and its predecessor agencies for use in annual uranium-reserve determinations. The use of these facilities for the calibration of radiometric field instruments used in remedial action is made possible by the commonality of the radiometric measurement technique for uranium and for radium. The use of these facilities will standardize remedial action measurements in a cost-effective manner.

6575 **An immodest proposal for dealing with radioactive wastes.** Weinberg, A.M. (Institute for Energy Analysis, Oak Ridge Associated Universities, Oak Ridge, TN). *Nuclear Materials Management;* **15**: 18-19(1986). (CONF-860654—).

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Unlike reactor accidents, waste disposal has generally been regarded by the technical community as a second-order problem. The nuclear community has never denied that a serious reactor accident could happen; the issue has always been what frequency and what consequences would be acceptable to the public. The author argues that the fears of nuclear waste expressed by the public are irrational (not based on scientific fact) and therefore proposes a monetary, rather than technical, approach to gain public acceptance.

## 0550 Safeguards, Inspection, And Accountability

*REFER ALSO TO CITATION(S) 6502, 7716*

**6576 (BNL—38316) Load-cell-based weighing system for weighing 9.1- and 12.7-tonne $UF_6$ cylinders.** McAuley, W.A.; Kane, W.R. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC05-84OT21400;AC02-76CH00016. 3p. (CONF-860654—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86013910.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

For the independent verification of $UF_6$ cylinder masses by the International Atomic Energy Agency (IAEA) at uranium enrichment facilities, an 18-tonne capacity Load-Cell-Based Weighing System (LCBWS) has been developed. The system was developed at Brookhaven National Laboratory and the Oak Ridge Gaseous Diffusion Plant and calibrated at the US National Bureau of Standards. The principal components of the LCBWS are two load cells, with readout and ancillary equipment, and a lifting fixture that couples the load cells to a cylinder. Initial experience with the system demonstrates that it has the advantages of transportability, ease of application, stability, and an attainable accuracy of 2 kg or better for a full cylinder.

**6577 (DOE/NBM—7001822) Technical data control considerations for rapidly advancing technologies. Final report.** Lewis, R.A.; Bert, W.; Diamond, J.M.; Johnson, D.; Mellen, M. (B-K Dynamics, Inc., Rockville, MD (USA)). Feb 1986. 101p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87001822.

The identification of rapidly advancing technologies has long been a key issue facing industry, government, and academia. Recent interest has been focused on distinguishing emerging technologies from mature technologies so that information generated from each may be managed for national security, investment, export control intelligence, and other applications on the basis of that distinction. Rapidly Advancing Technologies (RATs) encompass both emerging and mature critical technologies. The definitive attribute of a RAT is the rate at which an idea progresses to successful incorporation or application. The relative speed with which research moves from concept to application is most significant in areas having military criticality. The Rapidly Advancing Technologies project addresses in an innovative fashion those research and development activities in government, academic, and industrial laboratories characterized by rapid advancement. The subject and scope of this report is: (1) the delineation of the RATs concept and a means to characterize their progress systematically, (2) the presentation of an approach addressing rapid technological advancement to manage information releases, and (3) the development of technology identification techniques, generation of generic and specific control criteria, and examination of the utility of key decision tools to evaluate critical technology content for publication review. In summary, this project addressed in an innovative fashion the problem of defining what technologies need to be controlled (and also promoted), developed criteria and tools that were tested and validated, and upon that firm foundation developed prototype criteria for use in information release decisions.

**6578 (K/OA—6039) Demonstration and evaluation of the 20-ton-capacity load-cell-based weighing system, Eldorado Resources, Ltd., Port Hope, Ontario, September 3-4, 1986.** Cooley, J.N.; Huxford, T.J. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 1 Oct 1986. Contract AC05-84OT21400. 49p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002526.

On September 3 and 4, 1986, the prototype 20-ton-capacity load-cell-based weighing system (LCBWS) developed by the US Enrichment Safeguards Program (ESP) at Martin Marietta Energy Systems, Inc., was field tested at the Eldorado Resources, Ltd., (ERL) facility in Port Hope, Ontario. The 20-ton-capacity LCBWS has been designed and fabricated for use by the International Atomic Energy Agency (IAEA) for verifying the masses of large-capacity $UF_6$ cylinders during IAEA safeguards inspections at $UF_6$ handling facilities. The purpose of the Canadian field test was to demonstrate and to evaluate with IAEA inspectorates and with $UF_6$ bulk handling facility operators at Eldorado the principles, procedures, and hardware associated with using the 20-ton-capacity LCBWS as a portable means for verifying the masses of 10- and 14-ton $UF_6$ cylinders. Session participants included representatives from the IAEA, Martin Marietta Energy Systems, Inc., Eldorado Resources, Ltd., the Atomic Energy Control Board (AECB), and the International Safeguards Project Office (ISPO) at Brookhaven National Laboratory (BNL). Appendix A presents the list of participants and their organization affiliation. The two-day field test involved a formal briefing by ESP staff, two cylinder weighing sessions, IAEA critiques of the LCBWS hardware and software, and concluding discussions on the field performance of the system. Appendix B cites the meeting agenda. Summarized in this report are (1) the technical information presented by the system developers, (2) results from the weighing sessions, and (3) observations, suggestions, and concluding statements from meeting participants.

**6579 Comparing corrective actions with anomaly resolution.** Smith, B.W.; Harms, N.L. (Pacific Northwest Lab., Richland, WA 99352). *Nuclear Materials Management;* **15**: 483-487(1986). (CONF-860654—). Contract AC06-76RL01830.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Quality control and assurance are essential to any system to safeguard nuclear materials. Formalization of quality assurance activities for safeguards under the name of quality assurance has begun at several organizations. The approach to quality assurance for safeguards differs from quality assurance for facilities and hardware both in the definition and use of the product, which is information. Anomaly resolution is comparable to corrective actions in quality assurance of a hardware product, but is also part of the product of safeguards and, therefore, has its own quality assurance. This paper reviews corrective actions as compared to anomaly resolution.

**6580 Improved uranium MC & A by using good measurement QC and QA.** Dorsett, R.S. (Savannah River Plant, E.I. du Pont de Nemours and Co., Inc., Aiken, SC 29808). *Nuclear Materials Management;* **15**: 203-207(1986). (CONF-860654—). Contract AC09-76SR00001.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

In a purification process at the Savannah River Plant (SRP), a long-term gain trend existed in the accountability of enriched uranium. A major effort was made to improve uranium assays for input accountability. The isotope dilution-mass spectrometry method in use was converted from a volumetric basis to a gravimetric basis. Analysts were formally qualified for performing routine measurements by successfully completing tests on blind standards. Tight quality-control limits were established. The performance of analysts was closely monitored, and it became necessary to limit measurements to several analysts in order to achieve a sustained high level of performance. Quality control standards were monitored and improvements made to ensure valid standards. Standard and sample analytical results were examined for trends on a continuing basis. As improvements in uranium assays continued, it became evident that sampling was a major problem. With the implementation of a good sample validation program, improvements in uranium assays, and improvements in quality control, the uranium gain trend was eliminated.

# 07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

## 0702 Radiation Sources

**6581 (N—86-28385) Feasibility of a nuclear gauge for fuel quantity measurement aboard aircraft.** Signh, J.J.; Mall, G.H.; Sprinkle, D.R.; Chegini, H. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Aug 1986. 25p. (NASA-TM—87706; L—16132; NAS—1.15:87706). NTIS, PC A02/MF A01.

Capacitance fuel gauges have served as the basis for fuel quantity indicating systems in aircraft for several decades. However, there have been persistent reports by the airlines that these gauges often give faulty indications due to microbial growth and other contaminants in the fuel tanks. This report describes the results of a feasibility study of using gamma ray attenuation as the basis for measuring fuel quantity in the tanks. Studies with a weak Am-241 59.5-keV radiation source indicate that it is possible to continuously monitor the fuel quantity in the tanks to an accuracy of better than 1 percent. These measurements also indicate that there are easily measurable differences in the physical properties and resultant attenuation characteristics of JP-4, JP-5, and Jet A fuels. The experimental results, along with a suggested source-detector geometrical configuration are described.

### 0703 Isotopic Power Supplies

*REFER ALSO TO CITATION(S) 6778*

## 08 HYDROGEN

### 0801 Production

*REFER ALSO TO CITATION(S) 6603, 6669*

### 0802 Storage

6582 **Structural studies of the hydrogen storage material $Mg_2NiH_4$. 2. Monoclinic low-temperature structure.** Zolliker, P.; Yvon, K.; Jorgensen, J.D.; Rotella, F.J. (Universite de Geneve, Switzerland). *Inorganic Chemistry;* **25**: No. 20, 3590-3593(24 Sep 1986). Contract W-31-109-ENG-38.

The structure of the low-temperature phase of $Mg_2NiD_4$ was determined from time-of-flight neutron powder diffraction data collected at 298 K. It has monoclinic symmetry (space group C2/c, a = 14.343 (5) A, b = 6.4038 (10) A, c = 6.4830 (13) A, $\beta$ = 113.52 ()°, Z = 8) and contains four symmetry-independent D atoms. As expected, the D atoms surround the Ni atoms in a nearly regular tetrahedral configuration (average bond lengths Ni-D = 1.54 A, average bond angles D-Ni-D = 109.4°). Microtwinning parallel to (011) leads to severe anisotropic broadening of the diffraction peaks.

## 09 OTHER SYNTHETIC AND NATURAL FUELS

6583 **(ANL/CNSV—54) Pyrolysis of municipal solid waste. Annual report, July 1984-June 1985.** Helt, J.E.; Agrawal, R.K.; Myles, K.M. (Argonne National Lab., IL (USA)). Aug 1986. Contract W-31-109-ENG-38. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002352.

The pyrolysis of municipal solid waste is a promising method of producing useful fuels. However, several large-scale pyrolysis plants have not performed as expected, producing low yields of inferior products. Current ANL research is directed at gaining a better understanding of the basic thermokinetic mechanisms associated with the pyrolytic conversion of municipal solid waste. Initial results are given for determinations of pyrolytic ractivity for municipal solid waste components in a nonisothermal thermogravimetric analyzer and bench-scale reactor. The effects of heating rate and sample weight on overall degradation and product formation over the temperature range 300 to 475°C were determined. Gas chromatographic and gas chromatographic/mass spectrometric analyses of both the gaseous and liquid products are being performed. Tentative identifications were made of some liquid components from pyrolysis of municipal solid waste. Work was also initiated on a model to describe the decomposition of cellulosic material.

### 0901 Hydrocarbon Fuels

*REFER ALSO TO CITATION(S) 6925*

6584 **(AD-A—171535/8/XAB) Effects of potassium on carbon monoxide methanation over supported rhodium films. Technical report.** Dai, C.H.; Worley, S.D. (Auckland Univ. (New Zealand). Dept. of Chemistry). 22 May 1986. 17p. (AU-TR—8). NTIS, PC A02/MF A01.

The reaction of hydrogen with carbon monoxide over Rh/$Al_2O_3$ and Rh/$TiO_2$ catalytic films, some of which contained potassium as an additive, has been investigated. The presence of potassium caused the usual gem dicarbonyl and linear CO species on supported rhodium to dissociate at lower temperature than for catalysts containing no potassium. On the other hand, the bridged carbonyl species was significantly enhanced by the presence of potassium. The Rh/$TiO_2$ films to which potassium was added catalyzed the production of significant amounts of acetone and acetaldehyde as oxygenated products. It is likely that the bridged carbonyl species is the precursor to oxygenated products.

6585 **(AD-A—171553/1/XAB) Effect of potassium on the hydrogenation of CO and $CO_2$ over supported Rh catalysts. Technical report.** Worley, S.D.; Dai, C.H. (Auburn Univ., AL (USA). Dept. of Chemistry). 15 Jul 1986. 24p. (AU-TR—9). NTIS, PC A02/MF A01.

The reactions of hydrogen with carbon monoxide and carbon dioxide over Rh/Al2O3 and Rh/TiO2 films, some of which contained potassium as an additive, have been investigated. For the CO hydrogenation reaction the presence of potassium caused the dissociation or desorption of the gem dicarbonyl, linear CO, and carbonyl hydride species, while it led to an enhancement of the bridged carbonyl species. For Rh/TiO2 films the hydrogenation of CO produced acetone and acetaldehyde as oxygenated products; the bridged carbonyl species was the likely precursor of these products. For the CO2 hydrogenation reaction the presence of potassium caused the dissociation or desorption of all CO species, and oxygenated products were not produced. Potassium significantly poisoned both reactions toward the production of methane.

6586 **(CONF-860810—35) Understanding natural and induced gas migration through landfill cover materials: the basis for improved landfill gas recovery.** Bogner, J.E. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001517.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Vertical pressure and concentration gradients in landfill cover materials are being examined at the Mallard North Landfill in Dupage County, IL. The goal of this project is to understand venting of landfill gas and intrusion of atmospheric gases into the landfill in response to changing meteorological conditions (particularly barometric pressure and precipitation) and pumping rates at recovery wells. Nests of probes for directly measuring soil gas pressures have been installed in areas of fractured and unfractured silty clay till cover materials. The probes are at three depths: shallow (0.6 m), intermediate (1.2 m), and deep (in the top of the refuse). Preliminary results from fall 1985 suggest that soil gas pressures respond quickly to changes in barometric pressure but that concentrations of methane, carbon dioxide, nitrogen, and oxygen respond more slowly to changing soil moisture conditions. An important near-surface process that limits the total amount of methane available to a gas recovery system is the activity of methanotrophs (methane-oxidizing bacteria) in oxygenated cover materials. The results of this project will be used to quantify landfill mass balance relations, improve existing predictive models for landfill gas recovery systems, and improve landfill cover design for sites where gas recovery is anticipated.

## 0902 Alcohol Fuels

*REFER ALSO TO CITATION(S) 6600, 7360*

6587 **(PB—86-240413/XAB) Fuel ethanol and agriculture: an economic assessment. Agricultural economic report.** Grinnell, G.; Gavett, E. (Economic Research Service, Washington, DC (USA)). Aug 1986. 63p. (USDA/AER—562). NTIS, PC A04/MF A01.

Increased fuel ethanol production through 1995 would raise net farm income, benefiting mainly corn and livestock producers. Production of additional byproduct feeds would depress the price of soybeans. Large ethanol subsidies, which are required to sustain the industry, would offset any savings in agricultural commodity programs. Increased ethanol production would also raise consumer expenditures for food. Any benefits of higher income to farmers would be more than offset by increased Government costs and consumer food expenditures. Direct cash payments to farmers would be more economical than attempting to boost farm income through ethanol subsidies.

6588 **Methyl transfer to nucleophilic metal carbonylate anions in catalytic methanol homologation.** Roth, S.A.; Stucky, G.D.; Feder, H.M.; Chen, M.J.; Rathke, J.W. (Univ. of Illinois, Urbana). *Organometallics;* **3**: No. 5, 708-714(1984).

The kinetics of the stoichiometric reaction of methyltrialkylammonium cations with nucleophilic metal carbonylate anions was investigated in terms of its relationship to a new catalytic methanol homologation method. At high temperatures and pressures of $H_2$ and CO, a methyl group from each cation is incorporated into methane or ethanol. In the ionizing solvent, N-methylpyrrolidinone, the reaction using iron tetracarbonyl hydride anion is first order in both the methylammonium cation and iron carbonylate anion concentrations and zero order with respect to the partial pressures of hydrogen or carbon monoxide. The enthalpy and entropy of activation, in the temperature range of 180-210°C, are 44 kcal/mol and +17 eu, respectively. The second-order rate constants exhibit a primary kinetic salt effect, increasing with decreasing salt concentration. The rate constants also increased with decreasing dielectric constant of the solvent. The data are consistent with methyl group transfers (S/sub N/2) between ions as the rate-limiting step. At 200°C and 245 atm (3:1 $CO/H_2$) the second-order rate constants, $2.0 \times 10^{-4}$ $M^{-1}$ $s^{-1}$ for $Mn(CO)_5^-$, are a measure of the nucleophilicities of these carbonylates toward tetramethylammonium ion. In the case of the manganate system, the product selectivity (ethanol vs. methane) was found to be independent of $H_2$ or CO partial pressure between 61 and 184 atm but slightly dependent on the concentration of $Mn(CO)_5^-$. These factors are discussed in terms of reaction mechanism. 31 references, 6 figures, 3 tables.

# 13 HYDRO ENERGY

6589 **(DOE/ID/12254—1-Vol.3) Small hydropower development: The process, pitfalls, and experience: Volume 3, Technology development projects summary and analysis.** Christensen, J.P. (Morrison-Knudsen Engineers, Inc., San Francisco, CA (USA)). Jun 1986. Contract AC07-82ID12254. 379p. NTIS, PC A17/MF A01; 1; GPO Dep. File Number DE87002448.

The report summarizes technical, economic, construction and operations data from 23 small hydroelectric projects. Nineteen of these projects are being developed with financial assistance from DOE. As of July 1985, 13 projects are complete and six are still being developed. The other four projects have been developed independently and have been added to increase the diversity of the data. Trends in the project data have been identified by classifying the projects into categories according to site characteristics and comparing data by category. Feasibility level data and actual experience data are also compared to assess the accuracy of feasibility study projections of project cost, schedule and performance. Key findings of the report are that: (1) development of hydropower at existing dams and existing waterways is feasible; (2) each site has unique characteristics which must be taken into consideration when planning and implementing the project; (3) project costs are frequently underestimated; and (4) delays are common and mainly caused by complexities and uncertainties in activities such as licensing, power sales negotiations and project financing.

6590 **(EPRI-AP—4712) Comparative flow measurements: Grand Coulee pumping-generating plant unit P/G9. Final report.** Heigel, L.; Lewey, A.B.; Greenwood, J.B. (Bureau of Reclamation, Denver, CO (USA). Div. of Electrical, Mechanical, and Plant Design). Oct 1986. 381p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920048.

In extensive testing, two acoustic flow measurement systems compared well in accuracy and repeatability with conventional methods at a power plant at Grand Coulee Dam. Acoustic flow measurement systems offer utilities an inexpensive, real-time method for optimizing hydro plant efficiency.

### 1305 Economics And Management

6591 **(PB—86-243573/XAB) Small-scale hydroelectric power plant for the city of Alamogordo, New Mexico. Final report, 1 January 1981-31 January 1986.** Schoenmackers, R.; Miller, M.; Redman, C. (New Mexico State Univ., Las Cruces (USA). New Mexico Solar Energy Inst.). Jul 1986. 39p. NTIS, PC A03/MF A01.

The Alamogordo hydroelectric plant project was initially funded by the New Mexico Energy Research and Development Program in the Spring of 1980. This study includes the technical feasibility, turbine-type selection, controls, installation and operational requirements; and an economic evaluation of the project.

# 14 SOLAR ENERGY

6592 **Use of sol-gel thin films in solar energy applications.** Pettit, R.B.; Brinker, C.J. (Sandia National Labs., Albuquerque, NM, USA). *Solar Energy Materials;* **14**: No. 3-5, 269-287(Nov 1986). (CONF-850887—). Contract AC04-76DP00789.

From SPIE international technical symposium on optical and electro-optical engineers; San Diego, CA, USA (18 Aug 1985).

The sol-gel process uses metal alkoxides of network forming cations, such as Si, B, or Al, in alcohol/water solutions to form glass-like, polymeric networks in liquid solution. Thin films are formed by depositing the solution on a substrate by spinning, dipping or spraying. When the film is then heated to moderate temperatures (400-500 C), dense glass films or stable porous films are obtained. The use of sol-gel thin films in four solar energy materials applications is discussed: 1. Encapsulation of black chrome solar selective coatings improved the high temperature thermal stability by a factor of 2.7. 2. Formation of porous, antireflection coatings on glass envelopes used in solar thermal collectors increased the solar transmittance of the glass from 0.91 to greater than 0.96. 3. Double-layer, antireflection coatings of SiO/sub 2/ and TiO/sub 2/ on silicon solar cells reduced the solar reflectance of the cells from 0.36 to 0.04 and thereby improved cell efficiencies by 50%. 4. Protective coatings applied to silvered stainless steel substrates were used to form structural solar mirrors. Solar averaged specular reflectance values of 0.90 to 0.91 were obtained. 17 figs., 1 tab., 19 refs.

### 1401 Resources And Availability

6593 **(AD-A—171907/9/XAB) Global solar irradiance climatology of an intermountain region. Master's thesis.** Dobry, E.W. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA)). 1986. 98p. (AFIT/CI/NR—86-156T). NTIS, PC A05/MF A01.

A global solar-irradiance climatology of an intermountain region is developed using radiation data from ten measurement stations that form the Utah Solar Network. Statistics of daily insolation are prepared based on data collected from 1981-1984. Monthly and weekly periods of daily radiation are found to display a variably skewed frequency distribution. The median statistic is considered more realistic than the mean for determining the average value

of these time periods. Daily averages are presented on monthly maps showing the temporal solar energy distribution in Utah. Nonhomogenous terrain significantly distorts the normal latitudinal distribution pattern of irradiance. Effects on weather by the Great Salt Lake and Wasatch Mountain Range are discussed.

6594 **An integrating window pyranometer for beam daylighting measurements in scale-model buildings.** Baumann, F.S.; Place, J.W.; Thornton, J.; Howard, T.C. (Building Science Lab., Dept. of Architecture, Univ. of California, Berkeley, CA 94720). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1A, 486-493(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

An experimental device has been developed to measure the total amount of solar radiation transmitted through glazed apertures in scale-model buildings. The device, an integrating window pyranometer (IWP), has two distinguishing characteristics: (1) it provides a measure of transmitted solar radiation integrated over a representative portion of the model glazing, accounting for nonuniform radiation distributions; and (2) it is spectrally independent. In applications to scale model daylighting experiments, the IWP, together with photometric sensors mounted in the model, allows the direct measurement of the fraction of transmitted solar gains reaching the work plane as useful illumination, a convenient measure of the daylighting system performance. The IWP has been developed as part of an outdoor experimental facility to perform beam daylighting measurements in scale-model buildings. In this paper, the integrating window pyranometer is described; the results of calibration tests are presented and evaluated; the advantages and limitations of the device are discussed.

## 1405 Solar Energy Conversion

*REFER ALSO TO CITATION(S) 7415*

6595 (ESA-SP—43, pp vp) **Design and development of the Advanced Rigid Array (ARA) solar panel.** Horsselenberg, R.W.H. Feb 1986. NTIS, PC A16/MF A01.

From Proceedings of a Workshop on Composites Design for Space Applications; Noordwijk, Netherlands (15 Oct 1985).

The Advanced Rigid Array panel technologies are summarized: specific weight is less than 1.2 kg/sqm; can survive extreme thermal cycling (plus 80 to minus 180 C); excellent flatness and dimensional stability; extremely high stiffness properties due to application of GY-70 carbon fiber; high satellite interface flexibility; high panel sizing flexibility; and simple and low cost production. Developments include the establishment of panel technologies to obtain specific weights below 0.8 kg/sqm via open lay-up CFRP facesheet technology.

6596 (N—86-28125) **Voltage threshold for arcing for solar cells in LEO: Flight and ground test results.** Ferguson, D.C. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Mar 1986. 22p. (NASA-TM—87259; E—2951; NAS—1.15:87259; AIAA-Paper—86-0362; CONF-860130—8). NTIS, PC A02/MF A01.

From 24. AIAA aerospace science meeting; Reno, NV, USA (6 Jan 1986).

Ground and flight results of solar cell arcing in low Earth orbit (LEO) conditions are compared and interpreted. It is shown that an apparent voltage threshold for arcing may be produced by a strong power law dependence of arc rate on voltage, combined with a limited observation time. The change in this apparent threshold with plasma density is a reflection of the density dependence of the arc rate. A nearly linear dependence of arc rate on density is inferred from the data. A real voltage threshold for arcing for 2 by 2 cm solar cells may exist however, independent of plasma density, near -230 V relative to the plasma. Here, arc rates may change by more than an order of magnitude for a change of only 30 V in array potential. For 5.9 by 5.9 solar cells, the voltage dependence of the arc rate is steeper, and the data are insufficient to indicate the existence of an arcing increased by an atomic oxygen plasma, as is found in LEO, and by arcing from the backs of welded-through substrates.

6597 (N—86-31099) **Summary of mathematical models for a conventional and vertical junction photoconverter. Progress report, 1 March-30 June 1986.** Heinbockel, J.H. (Old Dominion Univ., Norfolk, VA (USA)). Jun 1986. 104p. (NASA-CR—177144; NAS—1.26:177144). NTIS, PC A06/MF A01.

The geometry and computer programming for mathematical models of a one-dimensional conventional photoconverter, a one-dimensional vertical junction photoconverter, a three-dimensional conventinal photoconverter, and a three-dimensional vertical junction solar cell are discussed.

6598 (N—86-31409, pp vp) **IBM PC-based math model for space station solar array simulation.** Emanuel, E.M. Jul 1986. NTIS, PC A99/MF E03. (NASA-CR—171931; NAS—1.26:171931).

In NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1985.

This report discusses and documents the design, development, and verification of a microcomputer-based solar cell math model for simulating the Space Station's solar array Initial Operational Capability (IOC) reference configuration. The array model is developed utilizing a linear solar cell dc math model requiring only five input parameters: short circuit current, open circuit voltage, maximum power voltage, maximum power current, and orbit inclination. The accuracy of this model is investigated using actual solar array on orbit electrical data derived from the Solar Array Flight Experiment/Dynamic Augmentation Experiment (SAFE/DAE), conducted during the STS-41D mission. This simulator provides real-time simulated performance data during the steady state portion of the Space Station orbit (i.e., array fully exposed to sunlight). Eclipse to sunlight transients and shadowing effects are not included in the analysis, but are discussed briefly. Integrating the Solar Array Simulator (SAS) into the Power Management and Distribution (PMAD) subsystem is also discussed.

6599 (NMRDI—2-74-4608) **Concentrating photovoltaic collectors: Final report.** Winker, J.D. (Illuminated Data, Inc., Albuquerque, NM (USA)). Oct 1986. 54p. NTIS, PC A04/MF A01 - NMRDI-Univ. of New Mexico, Suite M, 457 Washington SE, Albuquerque, NM 87108. File Number DE87900117.

A concentrating photovoltaic (PV) collector, proof-of-principle model, was constructed to demonstrate the advantages of reducing the overall size and bulk of PV collectors. Test results, cost estimates, construction methods and design principles are presented. The feasibility of using one sun silicon solar cells for concentrating PV collectors was demonstrated. The objectives of the program were met, demonstrating a cost effective PV module with a solar conversion efficiency of 14% at standard test conditions.

6600 (PB—86-232253/XAB) **Alternate pathway for industrialization: a biomass-based strategy.** Nayudamma, Y. (United Nations Industrial Development Organization, Vienna (Austria)). May 1985. 51p. (UNIDO-IS—532). NTIS, PC E04/MF E01.

Biomass is a bulk material with a large water content; it perishes easily and is seasonably variable. Therefore, technologies are needed to dry, handle, package, store, preserve and standardize the raw-material product. Biotechnology will influence the use of biomass as a fuel by (1) increasing the amount of biomass available, (2) improving its conversion into versatile fuels such as methane and alcohols, and (3) reducing the pressure on existing energy sources through the introduction of energy-saving processes and improved recoveries.

6601 **High-efficiency GaAs solar concentrator cells for space and terrestrial applications.** Hamaker, H.C.; Werthen, J.G.; Ford, C.W.; Virshup, G.F.; Kaminar, N.R. (Varian Research Center, Varian Associates, Inc., Palo Alto, CA 94303). pp 1441-1445 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

High-efficiency Al/sub x/Ga/sub 1-x/As/GaAs heteroface solar concentrator cells have been developed for both space and terrestrial applications. The cells, which were grown using metalorganic chemical vapor deposition (MOCVD), have been fabricated in both the p-n and n-p configurations. Magnesium and zinc are used as p-type dopoants, and Se is used as the n-type dopant. The space cells, which are designed for use in a Cassegrainian concentrator operating at 100 suns, AMO, have a circular illuminated area 4 mm in diameter on a 5 mm x 5 mm cell. These cells have exhibited flash-tested efficiencies as high as 23.6% at 28°C and 21.6% at 80°C. The terrestrial cells have a circular illuminated area 0.2 inches in diameter and are intended for use in a module which operates at 940 suns, AM1.5. These cells have shown a peak efficiency of 26% at 753 suns and over 25% at greater than 1000 suns.

6602 **Point contact silicon solar cells.** Swanson, R.M. (Stanford Univ.). pp 2144-2146 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

A new type of silicon concentrator solar cell has been developed. It is called the point-contact cell because the metal semiconductor contacts are restricted to an array of small points on the back of the cell. The point contact cell has recently demonstrated 22 percent conversion efficiency at one sun and 27.5 percent at 100 suns.

6603 **Sequential biphotonic processes in rhodium(III) phthalocyanines.** Muralldharan, S.; Ferraudi, G. (Univ. of Notre Dame, IN). *Journal of Physical Chemistry;* **87**: No. 24, 4877-4881(1983).

Visible irradiations, λ/sub excit/ = 640 or 590 nm, of rhodium(III) phthalocyanines with high photonic fluxes induce the same abstraction of hydrogen from solvent molecules that was previously reported for monophotonic ultraviolet photolysis. The dependence of the product yields on light intensity and complex concentration reveals that the visible photochemistry is associated with biphotonic processes. Indeed, no visible photochemistry was detected for low photonic fluxes. The direct observation of the low-lying $^3\pi\pi^*$ shows that the biphotonic photochemistry carries the excited molecules to the reactive $n\pi^*$ state. A mechanism for the sequential biphotonic photochemistry of the phthalocyanines is discussed. 33 references, 4 figures, 2 tables.

### 1406 Photovoltaic Power Systems

*REFER ALSO TO CITATION(S) 6601*

### 1407 Solar Thermal Power Systems

6604 **Optical properties of solid particle receiver materials. 1. Angular scattering and extinction characteristics of Norton Masterbeads.** Griffin, J.W.; Stahl, K.A.; Pettit, R.B. (Pacific Northwest Lab., Richland, WA, USA). *Solar Energy Materials;* **14**: No. 3-5, 395-416(Nov 1986). (CONF-850887—). Contract AC06-76RL01830;AC04-76DP00789.

From SPIE international technical symposium on optical and electro-optical engineers; San Diego, CA, USA (18 Aug 1985).

As part of the Solar Thermal Technology Program, the direct absorption of sunlight by free-falling particles inside a cavity receiver is being evaluated. The objective of the on-going optical properties measurement program is to obtain information to be used as input to radiation transfer models for prediction of receiver performance. Instrumentation and data analysis techniques have been developed to determine both the angular scattering properties and the scattering and absorption components of the extinction coefficient of candidate materials. This report summarizes the measurement procedures and presents data for an iron-doped alumina spheroid, Masterbeads, manufactured by Norton Chemical Company. This material exhibits good optical absorption properties over the solar insolation spectrum and favorable thermal and mechanical properties for temperatures up to 1000 C. The optical scattering and extinction properties are spectral; measurements were performed at 632.8 nm for convenience. The measurements were also simplified by arranging the spheroids in a falling curtain geometry of one particle nominal thickness. Data were obtained over a range of mass flow rates and particle areal densities. Photographic documentation of curtain particle density enabled calculation of mean particle scattering and absorption loss components in the absence of multiple-particle optical interactions. Prediction of optical extinction properties at other wavelengths is anticipated to be straightforward using spectral hemispherical reflectance measurements on bulk samples. Additional scattering and extinction data were obtained on transparent glass microspheres for comparison and as a verification of the measurement apparatus and procedures. 1 tab., 18 figs., 11 refs.

6605 **Optical properties of solid particle receiver materials. 2. Diffuse reflectance of Norton Masterbeads at elevated temperatures.** Stahl, K.A.; Griffin, J.W.; Pettit, R.B. (Pacific Northwest Lab., Richland, WA, USA). *Solar Energy Materials;* **14**: No. 3-5, 417-425(Nov 1986). (CONF-850887—). Contract AC06-76RL01830;AC04-76DP00789.

From SPIE international technical symposium on optical and electro-optical engineers; San Diego, CA, USA (18 Aug 1985).

An experimental system to measure the diffuse reflectance of a particulate sample over the wavelength range of 300 to 2500 nm at elevated temperatures up to 1000 C has been developed and implemented. A description of the experimental apparatus and measurement procedures, as well as optical reflectance data for the Masterbeads, are presented. Using the high temperature measurement system, the diffuse reflectance of Masterbeads changed by less than 1% for sample temperatures from 150 C to 930 C. However, after heating a sample for three hours at 1000 C in air, the solar absorptance measured at room temperature decreased from an initial value of 0.93 to 0.89. 7 figs., 6 refs.

### 1410 Solar Collectors And Concentrators

*REFER ALSO TO CITATION(S) 6604, 6605*

## 15 GEOTHERMAL ENERGY

### 1501 Resource Status And Assessment

6606 **(ETSU-R—39) Geothermal aquifers. Department of Energy R and D Programme 1976-1986.** Vaux, R. (ed.). (Energy Technology Support Unit, Harwell (UK)). 1986. 128p. HMSO, London price Pound 8.00.

A review is given of the R and D programme on geothermal aquifers funded by the UK Department of Energy between 1976 and 1986. After describing the nature of geothermal energy, the resource size within the UK is established. The economics for specific sites are presented. Finally the results and conclusions of the programme are given.

### 1502 Geology And Hydrology Of Geothermal Systems

*REFER ALSO TO CITATION(S) 7498*

6607 **(DOE/SF/12230—T1) Geothermal systems of the Mono Basin-Long Valley region, eastern California and western Nevada.** Higgins, C.T.; Flynn, T.; Chapman, R.H.; Trexler, D.T.; Chase, G.R.; Bacon, C.F.; Ghusn, G. Jr. (California State Dept. of Conservation, Sacramento (USA). Div. of Mines and Geology ; Nevada Univ., Las Vegas (USA). Div. of Earth Sciences). 1985. Contract FC03-84SF12230;FG03-84SF12207. 160p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87000339.

The region that includes Mono Basin, Long Valley, the Bridgeport-Bodie Hills area, and Aurora, in eastern California and western Nevada was studied to determine the possible causes and interactions of the geothermal anomalies in the Mono Basin-Long

Valley region as a whole. A special goal of the study was to locate possible shallow bodies of magma and to determine their influence on the hydrothermal systems in the region. (ACR)

### 1503 Geothermal Exploration And Exploration Technology

*REFER ALSO TO CITATION(S) 6609*

6608 **(PB—86-241122/XAB) Petrology of lower Permian volcanic rocks from the Larne No. 2 (geothermal) Borehole, Co., Antrim, Northern Ireland.** Harrison, R.K.; Styles, M.T.; Penn, I.E.; Davis, A.E. (British Geological Survey, Keyworth). 1985. 17p. NTIS, PC PC E04/MF E04.

Published as Report of the British Geological Survey, Vol. 17, No. 6 1985.

The isotopically-dated, Permian volcanic succession penetrated by the Larne No.2 Borehole, Co. Antrim, Northern Ireland was examined petrographically, by electron microprobe analyses of selected samples and by major oxide and trace element chemistry of the only substantial rock fragment recovered. The succession comprises eight stratigraphical units defined by characteristic and predominant lithology and by characteristic gamma-ray and sonic log signatures. The lowest unit penetrated, Breccio-Conglomerate and Sandstone, includes volcanic rocks ranging from olivine-basalt, olivine-free basalt, intermediate lavas, to rhyolite and felsite. These indicate denudation of a predominantly volcanic terrain probably deposited in a proximal alluvial-fan environment.

### 1505 Economic And Financial Aspects

*REFER ALSO TO CITATION(S) 6606*

### 1509 Geothermal Engineering

6609 **(LA—10661-HDR) Hot Dry Rock Geothermal Energy Development Program. Annual report, fiscal year 1984.** Franke, P.R.; Brown, D.W.; Smith, M.C.; Mathews, K.L. (Los Alamos National Lab., NM (USA)). Aug 1986. Contract W-7405-ENG-36. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002244.

The Hot Dry Rock Program in FY84 concentrated on achieving a connection between the two Phase II injection and production wells. Two massive hydraulic fracturing (MHF) experiments were conducted. The first MHF occurred in December 1983 when 21,300 $m^3$ (5.63 x $10^6$ gal) of water were injected into well EE-2. The experiment was terminated by equipment failure, but a huge reservoir was created. The other fracturing experiment was conducted in well EE-3 when 7570 $m^3$ (2 x $10^6$ gal) of water were injected. Neither experiment brought about a connection between the two wells. Improvements in seismic mapping techniques were notable during the year. These techniques identified the size and parameters of the big reservoir created by the MHF. Development has continued on the family of "slimline" downhole instruments. A "cross-well acoustic transceiver" has been developed for investigation of rock structures between wellbones, and chemically reactive tracers are proving useful to observe temperature changes in the system. Other related activities have included development of an analytical method for measuring radon concentration in vented gases, studies of geochemical reactions, potassium-argon dating of Fenton Hill cores and cuttings, and a laboratory study of natural convection in an inclined wellbore.

6610 **Earth stress measurements in deep granitic rock.** Kelkar, S.; Murphy, H.; Dash, Z. (Geological Engineering Group, Los Alamos National Lab., Los Alamos, NM 87545). pp 259-266 of Rock mechanics: Key to energy production. Littleton, CO; Society of Mining Engineers of AIME (1986). (CONF-860609—).

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

Nearly 30 estimates of the minimum earth stress were obtained from hydraulic stimulation tests in 5 boreholes at depths varying from 0.6 to 4.3 km in jointed granitic rock near the Valles Caldera in New Mexico. This site is located within the transition between the Colorado Plateau and Basin and Range provinces. Stresses were determined from open hole hydraulic fracturing experiments conducted with water at pressures up to 48.3 MPa (surface). The virgin bottomhole temperatures ranged up to 327°C. Pressure records show no evidence of rock breakdown, indicating injection into pre-existing joints. A typical pressure response consists of an early wellbore storage period followed by linear fracture flow, which then evolves into a steady pressure, fracture extension mode. Shut-in behavior is characterized by a sharp pressure drop followed by a more gradual decay. The minimum earth stress shows a general linear trend with depth, increasing with a gradient of 19 MPa/km. A low stress anomaly occurs from 2490 to 3100 m where the minimum stresses are as much as 28 MPa lower.

### 1520 Geothermal Data And Theory

*REFER ALSO TO CITATION(S) 7504*

## 16 TIDAL AND WAVE POWER

### 1607 Tidal Power Plants

6611 **(CEGB-TPRD/M—1522/N85) Optimal control for the Severn Barrage.** Nicol, D.A.C.; Birkett, N.R.C. (Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs.). Nov 1985. 8p. BLDSC, Boston Spa, Wetherby, West Yorks.

The economics of a barrage scheme will depend crucially on how much energy can be extracted. This energy will depend on the line of the barrage across the Severn, the number of turbines and sluices installed and their head and flow characteristics. With such a scheme defined, mathematical models have been used to estimate how much energy can be generated. The amount of energy that can be generated will depend on the exact operating strategy. These calculations can be repeated for different strategies and a rough optimum can be obtained. A mathematical formulation of the tidal equations which automatically finds the optimum power has been developed. The model at present allows for either ebb or two way generation, but could also be extended to include extra features such as pumping.

### 1608 Wave Energy Converters

6612 **(ETSU-WV—1570) Bristol cylinder. Vol. 3A - technical appraisal.** (Kennedy and Donkin, Consulting Engineers, Woking, Surrey (UK); Department of Energy, London (UK); UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Rendel Palmer and Tritton, London (UK)). Jun 1983. 208p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

Work performed under contract for ETSU [Harwell] on behalf of the Department of Energy.

A consultants' report is presented on a UK funded wave energy device known as the Bristol Cylinder. A detailed engineering appraisal is given for each component and aspects of the device including installation, power generation and maintenance. Finally the discounted cost of energy from the device is assessed. For all topics the views of the consultants are compared with those of the team developing the Bristol Cylinder and where discrepancies occur, these are explained and discussed.

6613 **(ETSU-WV—1570-P17) Part A - introduction and symbols. Part B - productivity and costing. Part C - global UK wave energy resource. Part D - environment. Vol. 2A - supporting information and methodology.** (Kennedy and Donkin, Consulting Engineers, London (UK); Department of the Environment, London (UK); UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Rendel Palmer and Tritton, London (UK)). Jun 1983. 300p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

Consultants' 1983 report.

Volumes 2A and 2B contain all the background information developed by the Consultants on which this report and assessment is based, using the form and content of the original Papers, and referenced accordingly. Symbols, definitions and formulae are given. An overview of productivity is presented, and the wave climate off South Uist, productivity and availability models, assessing the cost of a 26W scheme and analysis of civil construction costs are discussed. Global, U.K. wave energy resource, shallow water and floating devices and environmental conditions are considered.

6614 **(ETSU-WV—1570-P21) N.E.L. Bottom Standing Terminator. Vol. 3C(NT) - technical appraisal.** (Kennedy and Donkin, Consulting Engineers, London (UK); Department of the Environment, London (UK); UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Rendel Palmer and Tritton, London (UK)). Jun 1983. 171p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

Consultants' 1983 report.

The Consultants have estimated the cost of converting wave energy to electrical energy by an array of NEL Bottom Standing Terminator devices and transmitting this to a substation to be located close to Hoe Point on the west coast of Skye. The size of the scheme which has been assessed and costed is based on the Consultant's estimate, made in 1982, of the number of devices needed to give a rated output of 2GW at Skye for 5% of the year, on the basis of 100% availability.

6615 **(ETSU-WV—1570-P24) Belfast Device. Vol. 3C(B) - technical appraisal.** (Kennedy and Donkin, Consulting Engineers, London (UK); Department of the Environment, London (UK); UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Rendel Palmer and Tritton, London (UK)). Jun 1983. 147p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

Consultants' 1983 report.

A brief history of development is given and design details, engineering appraisal, inspection and maintenance are discussed. Reliability and availability, performance and productivity and costing are considered.

6616 **(ETSU-WV—1570-P26) Edinburgh Duck. Vol. 3D - technical appraisal.** (Kennedy and Donkin, Consulting Engineers, London (UK); Department of the Environment, London (UK); UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Rendel Palmer and Tritton, London (UK)). Jun 1983. 188p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

Consultants' 1983 report.

The consistent philosophy of the Edinburgh Laing Team has been to design, without being limited by current technology, a scheme which will extract a high proportion of energy from the wave front, be simple to install, require minimal life cycle maintenance, and no maintenance at sea. To maximise energy capture, the device will be located in deep water (100m) where it is claimed by the Development Team that the benefits in terms of higher and more persistent waves will outweigh the cost penalties from the need for longer mooring rodes, longer power transmission cables and longer sailing times for access. An engineering appraisal is given and inspection, reliability, performance and costing of the 2GW scheme are discussed.

# 17 WIND ENERGY

## 1706 Wind Energy Engineering

6617 **(BEOP-CR—9) Integral tip vane development program: proposal for the first part.** (Netherlands Energy Research Foundation, Petten). Apr 1984. 40p. (In Dutch). NTIS, PC A03/MF A01.

The development, construction, and testing of a high speed 25 m diameter tip vane rotor to prove the feasibility of a high speed concept (the low speed concept shows good performance), and to carry out preliminary studies on behalf of optimization and upscaling is proposed. Financial/organizational aspects and the distribution of the activities per project-participant are elucidated.

6618 **(DOE/BP/11191—2) Cape Blanco wind farm feasibility study. Technical report No. 2, civil engineering.** (Pacific Power and Light Co., Portland, OR (USA)). Sep 1986. Contract AC79-83BP11191. 67p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002220.

An investigation of the feasibility of developing a wind farm near Cape Blanco, Oregon, requires a plan for civil engineering and preliminary site construction activities. In this report, plans for such activities and related cost estimates are presented for a wind farm using either a Boeing MOD-2 or FloWind 170 wind turbine generator.

6619 **(DOE/NASA—0247-2) WEST-3 wind turbine simulator development. Volume 2. Verification.** Sridhar, S. (Paragon Pacific, Inc., Torrance, CA (USA)). Jul 1985. Contract AI01-76ET20320. 31p. (NASA-CR—174982; PPI-FID—300102). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001863.

The details of a study to validate WEST-3, a new real time wind turbine simulator developed by Paragon Pacific Inc., are presented in this report. For the validation, the MOD-O wind turbine was simulated on WEST-3. The simulation results were compared with those obtained from previous MOD-O simulations, and with test data measured during MOD-O operations. The study was successful in achieving the major objective of proving that WEST-3 yields results which can be used to support a wind turbine development process. The blade bending moments, peak and cyclic, from the WEST-3 simulation correlate reasonably well with the available MOD-O data. The simulation was also able to predict the resonance phenomena observed during MOD-O operations. Also presented in the report is a description and solution of a serious numerical instability problem encountered during the study. The problem was caused by the coupling of the rotor and the power train models. The results of the study indicate that some parts of the existing WEST-3 simulation model may have to be refined for future work; specifically, the aerodynamics, and the procedure used to couple the rotor model with the tower and the power train models.

6620 **(ETSU-N—1-86) Aerodynamics and control of wind turbines. Proceedings of a BWEA/DEN Workshop, Harwell, Oxon, 25 February 1986.** McAnulty, K.F. (ed.). (Energy Technology Support Unit, Harwell (UK)). Feb 1986. 157p. (CONF-8602107—). BLDSC, Boston Spa, Wetherby, West Yorks.

From BWEA/DEN workshop on aerodynamics and control of wind turbines; Harwell, Oxon, UK (25 Feb 1986).

Five papers were presented on the aerodynamics and control of horizontal axis and vertical axis wind turbines at the BWEA-DEN Workshop held at Harwell in February 1986. All papers together with any relevant discussion were selected and indexed separately.

6621 **(N—86-29420) Evaluation of two performance prediction methods for horizontal-axis wind turbines by comparison with experimental results.** Vanegmond, J.A. (National Aerospace Lab., Amsterdam (Netherlands)). 1985. 39p. (NLR-TR—85028-L). NTIS, PC A03/MF A01.

A computer program based on Glauert's blade element theory and a program based on a rotating lifting line theory with nonlinear vortex wake modeling were compared with experimental results for two horizontal-axis wind turbines. In spite of the higher level of sophistication of the lifting line/vortex wake model, the quality of the predicted characteristics of both methods is equal. The blade element theory is far less expensive in computing costs than the rotating lifting line theory. Large differences between theory and experiment can only be explained partly from uncertainties in the aerodynamic characteristics of the basic airfoil sections. For the two different turbine configurations considered, no systematic differences between theory and experiment are found, raising questions about the reliability of the measured data. The rotating

lifting line theory suggests that a slightly different optimum blade geometry with wider tip chord than predicted by blade element theory might lead to a performance increase.

6622 **(REPT—5-010880-PT-2) Design criteria for small wind turbines. Part 2: wind characterizing.** Beugeling, G.L.H.; Vermeulen, P.E.J. (Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands)). Aug 1985. 126p. (In Dutch). (MT-TNO—8724-11344). Issuing Activity.

A calculation model to determine turbulent wind velocity and Wind Direction Fluctuations (WDFs) on a rotating wind turbine rotor was developed to draw up simply applicable and rotor type differentiated design criteria. Using statistical methods, fatiguing and extreme wind gusts as well as turbulent WDFs were constructed and determined as dependent upon criteria chosen (exceed chances). Interstationary (mesoscale) WDFs expected were estimated using literature about squalls and front systems. A second model to determine wind shear for fatigue calculation was also developed. Design gusts (for different classes of hourly average wind velocity at axis height) turbulent WDFs, and wind shear are given for a small wind turbine.

# 20 ELECTRIC POWER ENGINEERING

## 2001 Power Plants And Power Generation

*REFER ALSO TO CITATION(S) 6437*

6623 **(AD-A—171769/3/XAB) Structural design of coal-fueled power-plant ductwork. Doctoral thesis.** Rader, S.P. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA)). 1986. 259p. (AFIT/CI/NR—86-153D). NTIS, PC A12/MF A01.

There exists, currently, no comprehensive procedures for design of coal-fueled power plant ductwork in the publicly available literature. This dissertation presents such a procedure. An overview of the ductwork design environment, including major components of the air and flue-gas flow paths, design loads and temperatures, corrosion considerations, and physical configurations, is given. Design criteria for materials, corrosion inhibition, minimum plate thicknesses, temperature effects, allowable stresses and deflections, and vibrations are proposed. A detailed design procedure based on the allowable stress design philosophy is presented, and computer programs implementing the design procedure are provided. An alternate design procedure based on the Load and Resistance Factor Design approach is also discussed. The allowable stress design procedure is applied to a horizontal section of rectangular ductwork and the results are compared to a previous design accomplished by hand calculations. The proposed design procedure provides savings in both ductwork material and fabrication labor, and consumes significantly less design time than the by-hand design approach.

6624 **(N—86-28122) 20 kiloHertz space station power system.** Hansen, I.G.; Wolff, F.J. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 10p. (NASA-TM—88801; E—3140; NAS—1.15:88801; CONF-8609192—1). NTIS, PC A02/MF A01.

From 19. annual electronics and aerospace conference; Washington, DC, USA (9 Sep 1986).

The space station represents the next major U.S. commitment in space. The efficient delivery of power to multiple user loads is key to that success. In 1969, NASA Lewis Research Center began a series of studies with component and circuit developments that led to the high frequency, bi-directional, four quadrant resonant driven converter. Additional studies and subsequent developments into the early 1980's have shown how the high frequency ac power system could provide overall advantages to many aerospace power systems. Because of its wide versatility, it also has outstanding advantages for the Space Station Program and its wide range of users. High frequency ac power provides higher efficiency, lower cost, and improved safety. The 20 kHz power system has exceptional flexibility, is inherently user friendly, and is compatible with all types of energy sources - photovoltaic, solar dynamic, rotating machines or nuclear. Lewis has recently completed development under contract a 25 kW, 20 kHz ac power distribution system testbed. The testbed demonstrates flexibility, versatility, and transparency to user technology as well as high efficiency, low mass, and reduced volume.

6625 **Emerging technology for burning coal for district heating and cooling systems.** Feibus, H. (Coal Utilization Systems, U.S. Dept. of Energy). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1B, 119-130(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

There are several technologies currently under development that have the potential to enable existing district heating systems to be converted from oil or gas to coal. These technologies are coal water mixtures (CWM) and advanced combustors. For certain applications, these technologies may be used in conjunction with an advanced coal preparation process.

## 2002 Environmental Control Technology

*REFER ALSO TO CITATION(S) 6460, 7343, 7346*

6626 **Study on the application of fluidized bed combustion.** Huovilainen, R.T. (Power Plant Engineering, Lappeenranta Univ. of Technology Dept. of Energy Technology, Lappeenranta). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1B, 103-118(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

ECE's Executive Body made a decision to carry out a special study on the application of fluidized bed combustion technology to energy production. The Nordic Council of Ministers announced its readiness to finance the study. The aim of the special study was to evaluate the possibility of diminishing harmful emissions, especially of sulfur and nitrogen oxide, by using fluidized combustion technology in energy production in a way that would satisfy users' demands for reliability and economy. The study began on July 1, 1984, with the sending out of questionnaires to plant manufacturers, users, and consultants. During autumn 1984 and the beginning of 1985, several plant manufacturers and users were visited to find out the current level of and future trends in fluidized bed technology. The main findings of the work are presented in this paper. As a conclusion, it can be stated that fluidized bed technology is commercially viable. It is economically feasible, reliable, and environmentally fully acceptable. The experience gained is from small and medium-size plants, but there is no reason to doubt it would also be suitable for large plants.

## 2003 Power Transmission And Distribution

6627 **(EPRI-EL—3880-Vol.2) Predicting transmission outages for system reliability evaluations. Volume 2. Restoration modeling and improved weather model. Final report.** Landgren, G.L.; Schneider, A.W. Jr.; Bhavaraju, M.P. (Commonwealth Research Corp., Chicago, IL (USA); Commonwealth Edison Co., Chicago, IL (USA); Public Service Electric and Gas Co., Newark, NJ (USA)). Oct 1986. 131p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920079.

Research in phase 2 of this project developed a single-state weather model that recognizes the proximity of pairs of transmission units within a storm area. The new model predicted 75% of observed storm-caused outages for a 17-year period.

6628 (ORNL/TM—10021, pp 23-37) **DOE perspective.** Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The Athens automation and control experiment is presented in summary form. The goal of the experiment is to develop a large-scale distribution automation test bed which will analyze and verify control strategies on the power systems reliability, economy and efficiency. Significant milestones in the development of the system; phases of research development, and technology implementation; and technology transfer are discussed.

6629 (ORNL/TM—10021, pp 39-58) **Description of project and overall status.** Purucker, S.L. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

An overview designed to (1) establish the project objectives and rationale, (2) identify project organization and industry participation, and (3) communicate project experiment status is presented. The AACE experiments are designed to quantify the benefits associated with automation and, through experimentation, to determine the minimal amount of hardware required to support automation functions. In addition, the experiments are designed to ultimately relate the Athens experimental data on a cost/benefit basis so that utilities considering distribution automation will have the results of real world automation experiences. The development and testing of control strategies are required to generate experimental data and to demonstrate the strengths and weaknesses of an automated distribution system. The experiments are divided into three areas: load control, volt/var control, and system reconfiguration. Load control deals with customer monitoring and control. Volt/var control deals with voltage regulator and capacitor monitoring and control. Volt/var control deals with voltage regulator and capacitor monitoring and control. System reconfiguration deals with breaker and distribution switch control. The experiments will be conducted in two phases: (1) a Learning year to determine power system and customer responses to various control actions so that models can be verified, modified, or created; and (2) an Integrated year to combine operation of customer load control and capacitor and regulator control, as well as breaker and switch control to examine the interaction of control actions and responses. The personnel organization of the AACE is presented.

6630 (ORNL/TM—10021, pp 59-72) **EPRI perspective.** Gellings, C.W. (Electrical Power Research Institute, Palo Alto, CA). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

EPRI's involvement in the Athens Automation and Control Experiment (AACE) derives from the desire to develop analytical tools and to obtain results that could be widely used in the utility industry, as well as to capitalize on the availability of a high quality data-collection mechanism - the AACE. By augmenting the direct load control (DLC) experimental design, load monitoring, and analysis efforts of the AACE, EPRI will contribute in three major areas of interest to the utility industry. These areas include the development of transferable analysis tools for demand-side management (DSM) program design, implementation, and evaluation; the construction of a transferable data base for characterizing residential programs; and an assessment of customer response to DLC programs. At the core of the project is the realization that three classes of factors interact to affect both the impact on loads and the response of customers to DLC. These classes can be categorized as environmental, including temperature and humidity; physical, including household characteristics, appliance efficiency and cycling strategy; and behavioral, including thermostat setting, household operations, prices and incentives, and income. These research products and their supporting analyses will contribute to an integrated approach for utility demand-side planning.

6631 (ORNL/TM—10021, pp 73-84) **Communication and control system.** Purucker, S.L. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The Integrated Distribution Control System (IDCS) is the hardware system on which the experiments will be conducted. The IDCS consists of two separate types of equipment: (1) a traditional Supervisory Control and Data Acquisition (SCADA) system modified for distribution automation and (2) the interface equipment, which is that equipment required to link the SCADA system to traditional utility equipment. Additionally, Electric Power Research Institute (EPRI) is providing a separate customer appliance monitoring system, the Electric ARM system. EPRI is also a codesigner of the load control experiments. The communication and control system is an experimental tool that will be used to conduct the AACE. The communication and control system combines standard and nonstandard (custom) hardware and coordinates both types of hardware through a SCADA software program. The design and communication capabilities of the communication and control system are reviewed.

6632 (ORNL/TM—10021, pp 85-109) **Instrumentation.** Wetherington, G.R. Jr. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

Automation systems and their targeted processes may not be directly compatible with one another. Automation systems typically interface with low-level standard signals while processes are usually characterized by physical and nonstandard electrical states. This interface problem is normally solved by the addition of instrumentation between the automation system and the process. In addition to the interface function, instrumentation can also perform useful work, such as information preprocessing and compensation for environmental factors. A particular instrumentation requirement can usually be satisfied by following a plan that consists of four steps: (1) definition of the interfaces, (2) identification of the functional requirements, (3) selection, and (4) maintenance. Even with the best instrumentation and particularly during initial system shakedown problems will be encountered. Steps to correct these problems are discussed.

6633 (ORNL/TM—10021, pp 111-126) **Residential appliance monitoring.** Broadaway, E.R. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

Residential appliance monitoring was included in the load control experiment of the Athens Automation and Control Experiment on the advice of the utility advisory group. The purpose of this monitoring was fourfold: (1) to build load models for transfer to utilities; (2) to allow correlation between individual appliance loads and the total household load; (3) to study the relationship of interior temperature and space heater, air conditioner, or heat pump duty cycles; and (4) to provide support in the other experimental areas of system reconfiguration and volt/var control. The specific appliances chosen for monitoring were water heaters, central space heaters, central air conditioners, and heat pumps. In addition, total household load and interior temperature will be monitored. A total of 200 residences will have residential appliance monitoring. From one to four of the selected loads will be monitored at each residence. The residences and monitored loads at each were selected from one of four strata identified by Minimax (EPRI contractor) and ORNL researchers based on energy use patterns. Power consumed was determined on 5-min intervals, and the total for each interval is recorded. These data are stored in hardware at the residence and transferred to the ORNL computer, AACETS, at a predetermined time using the customer's telephone line.

6634 (ORNL/TM—10021, pp 127-128) **Equipment installation.** Fortson, N.D.; Monteen, L.D. (Athens Utilities Board, TN). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The installation of distribution system interface equipment is outlined. The equipment includes pole top units, remote terminal units, power reclosures, motor operated device switches, var controllers, distribution control receivers, current transformer/potential transformers, and fault sensors.

6635 (ORNL/TM—10021, pp 131-161) **Experimental data and data management.** Hu, P.S. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The Athens Automation and Control Experiment's data bases and the management of these data are described. Five major categories of data are being maintained: (1) integrated distribution control system data which monitor the distribution remote terminal unit, single- and three-phase pole top unit, feeder loads, and total household loads; (2) household appliance-specific data; (3) household audit data; (4) pre-experiment substation loads; and (5) historical data on substation loads and weather. The data processing procedures for this experiment present a major challenge for the following reasons: (1) the tremendous volume of data that is collected on a daily basis, (2) the need to reduce the repetitious programming tasks for the processing of the data, and (3) the data structure requirements for subsequent data analyses. Computer utility programs were developed to back up the raw data in the event of a possible computer system crash, to create statistical analysis system files, to condense data volume, and to reorganize the data structure for subsequent data analysis. All of these utility programs were automated to reduce repetitious programming tasks. There are approximately 20 data sets being maintained, and more than 10 megabytes of data being collected on a daily basis. The automated data processing procedures allow one to meet the challenges and to devote resources to data interpretation and analysis.

**6636** (ORNL/TM—10021, pp 163-201) **Load control.** Reed, J.H. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The hardware, the structure of the experiments, and some preliminary data from the load control portion of the Athens Automation and Control Experiment are described. The objectives include: (1) characterization and modeling for operations and for building an impact assessment model that is transferable to other utilities; (2) the evaluation of alternative control strategies; (3) the evaluation and identification of customer comfort constraints; (4) the evaluation of customer acceptance; and (5) evaluation of instrumentation requirements. One to three residential appliances chosen from among water heaters, central air-conditioners, central electric heating units, or heat pumps will be independently controlled in 2000 customer homes. Energy use will be monitored at the appliance level in 200 homes, at the household level in approximately 350 homes, at 51 locations on the feeders, and at each of the feeder service points at the substation. In addition, information about appliances, characteristics of the thermal envelope, end customer lifestyle and demographics are being gathered for each household having a load control receiver. Weather information and some indoor temperature data are also being collected. The results of these studies are discussed.

**6637** (ORNL/TM—10021, pp 203-212) **Load control experiment background.** Braithwait, S.D. (Electrical Power Research Institute, Palo Alto, CA). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The project objectives of (1) developing transferable tools for program design and assessment, and (2) developing an analysis data base that accurately represents the residential DLC program are discussed. The analysis design included the development of a plan for analyzing the large amount of data to be collected during the load control experiments as well as specification of an impact assessment model. This model, known as the Duty Cycle Impact Model, will evaluate the impact of the various DLC strategies by assessing changes in the natural operation, or duty cycle, of the controlled appliances. Deliverables in the project include the DESIGN Model, now in a research grade, pre-release version. This PC-based model provides the utility analyst with a valuable tool for use in evaluating DLC experiments before implementation, thus enhancing the likelihood of a successful experiment. Also to be produced are the Handbook on DSM Experimentation, which will serve as a guide for utility analysts in addressing issues relevant for utility experiments, and, most important, a transferable model of DLC impacts.

**6638** (ORNL/TM—10021, pp 213-233) **Analysis and results.** Newton, B.K. (Minimax Research Corp., Berkeley, CA). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The foundation for the analysis of the data now being collected from the EPRI ARMs submetering group in Athens, Tennessee is described. The emphasis of the presentation is placed on a detailed discussion of the modeling approach that has been developed for analyzing the Athens end-use data and the development of a transferable model for direct load control (DLC) impacts. The EPRI portion of the AACE is conveniently partitioned into design, implementation, and analysis evaluation phases. The design phase encompassed initial specification of the model to be used in data analysis, careful preparation of a plan for sampling AUB customers based on seasonal usage and inferred appliance holdings, as well as specification of the end-use metering equipment necessary to monitor the experiments. Implementation activities included development of an indoor temperature-sensing device to provide a physical measure of DLC impacts as well as completion of an experiment plan that specifies which control actions will be implemented for each appliance under study. The analysis phase is now beginning and will employ the Duty Cycle Impact Model for assessing baseline behavior control impacts, and customer acceptance. The results of the analysis are outlined.

**6639** (ORNL/TM—10021, pp 235-258) **Athens Automation and Control Experiment Test System (AACETS) and its role in 1985.** Wetherington, G.R. Jr. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The AACETS is a general purpose support tool that was developed by ORNL to support the activities of the Athens Automation and Control Experiment (AACE). The AACETS consists of two major subsystems. The first is a scaled-down copy of the Athens IDCS that features the same type of host computer, software, and database as the IDCS. The second subsystem is an electrical distribution system simulator called the smart test panel. The smart test panel is based on a commercially available automation device called a programmable controller and is used to generate electrical signals that are monitored by the control subsystem as KV, KW, KVAR, etc. Previously gathered distribution system data can be tabularized in the programmable controller's memory and sequentially accessed and transferred as electrical signals to the control subsystem such that they appear like those associated with the AUB electrical distribution system. As a productivity enhancer, the AACETS provides the facilities for software development, the capabilities for more thorough verification and validation of software prior to installation on the IDCS, and it also minimizes project dependency on system support. In addition, the AACETS has assisted in the procurement, installation, and shakedown of the IDCS. The AACETS provided support in three major areas during 1985. These areas are system management, data acquisition, and software development. These areas are discussed.

**6640** (ORNL/TM—10021, pp 259-328) **Summary of volt/var presentations.** Rizy, D.T.; Sullivan, R.L. Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

The purpose of the volt/var experiments is to determine the benefits of real-time computer-automated capacitor and regulator control. The objectives for implementing real-time volt/var control on the Athens Utilities Board's (AUB) distribution system are to (1) determine whether or not real-time computer-automated capacitor control is effective in reducing line losses and in providing var support for the transmission system; (2) determine whether computer-automated regulator control is effective in reducing feeder voltage drops, ensuring acceptable voltage levels and providing a means of reducing load (via voltage reductions); (3) determine the type of application software needed to implement real-time volt/var control; (4) determine whether the type of computer, communications, and control equipment is adequate for collecting data and for implementing volt/var control actions; (5) determine the additional

benefits of coordinating volt/var control with load control and system reconfiguration; and (6) identify the requirements for future-generation distribution automation systems that will employ volt/var control. The results of the experiments are presented.

6641 (ORNL/TM—10021, pp 329-406) **System reconfiguration.** Lawler, J.; Patton, J.B. (Univ. of Tennessee, Knoxville). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

System configuration involves the automated monitoring of the distribution system operating conditions and the remote control of distribution switching elements. Automated monitoring allows abnormal or undesirable network conditions, such as permanent faults or imminent component overloads, to be recognized at the distribution system control center. Remote control of switches allows the system operator to reconfigure the network in order to avoid such problems or minimize their effect on system operation. Potential benefits of automated system reconfiguration include system reliability and enhanced capacity utilization. The focus of this work is the computer software that has been developed to support experiment design and analysis and on the results of the initial round of experimentation.

6642 (ORNL/TM—10021, pp 407-423) **Economic evaluation of the Athens Automation and Control Experiment.** McKinley, K.F. (Baltimore Gas & Electric Co., MD). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

Distribution automation is similar to most other projects attempted by electric utilities; the project must be justified on an economic basis. Upper management is very interested in the total project benefits and cost, the bottom line. Tools are available to perform the economic analysis. Benefits are being calculated for the three experimental areas and costs are being recorded for the AUB system. Experiments will be repeated in order to obtain results which will prove consistent. Consistent results will provide confidence in the development of more accurate figures for use in projecting benefits and costs for other utilities. Experimental results will be used as a basis for extending benefits and costs to larger electric utility systems and to present an idea of what distribution automation could accomplish on a larger scale. Finally, planning studies at a large utility will be performed to compare a nonautomated base case expansion with an automated alternative for the same study area.

6643 (ORNL/TM—10021, pp 425-435) **Overview of some major utility distribution automation and load control projects.** Markel, L.C. (Electrotek Concepts, Inc., Mountain View, CA). Aug 1986. NTIS, PC A19/MF A01. File Number DE86015979.

In Athens automation and control experiment project review meeting, Knoxville, Tennessee, December 3-5, 1985.

An overview of some major utility distribution automation and control projects is presented in outline form. The objectives of the work were to: (1) test a bi-directional communication system, (2) determine the cost/benefit of various automation functions, (3) develop effective control strategies and operating procedures, and (4) determine the design for a full-scale implementation. Conclusions are presented and discussed.

# 21 NUCLEAR POWER PLANTS

*REFER ALSO TO CITATION(S) 6682*

6644 **(RISO-R—519) DES-model and its applications.** Grohnheit, P.E. (Risoe National Lab., Roskilde (Denmark)). May 1986. 83p. NTIS (US Sales Only), PC A05/MF A01. File Number DE87750159.

This report describes the use of the Danish Energy System (DES) Model, which has been used for several years as the most comprehensive model for the energy planning. The structure of the Danish energy system is described, and a number of energy system parameters are explained, in particular the efficiencies and marginal costs of combined heat and power (CHP). Some associated models are briefly outlined, and the use of the model is described by examples concerning scenarios for the primary energy requirements and energy system costs up to the year 2000, planned development of the power and heating systems, assessment of nuclear power, and effects of changes in the energy supply system on the emissions of $SO_2$ and NOsub(x). 17 refs.

## 2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

*REFER ALSO TO CITATION(S) 6667, 6703, 6711, 6712, 6717, 6718, 6719, 6721, 6723, 6724, 6726, 6728, 6730, 6737, 6738*

6645 (NUREG/CP—0080-Vol.2, pp 871-883) **Generalized perturbation theory for LWR depletion analysis and core design applications.** White, J.R.; Frank, B.R. (Univ. of Lowell, MA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A comprehensive time-dependent perturbation theory formulation that includes macroscopic depletion, thermal-hydraulic and poison feedback effects, and a criticality reset mechanism is developed. The methodology is compatible with most current LWR design codes. This new development allows GTP/DTP methods to be used quantitatively in a variety of realistic LWR physics applications that were not possible prior to this work. A GTP-based optimization technique for incore fuel management analyses is addressed as a promising application of the new formulation.

6646 (NUREG/CP—0080-Vol.2, pp 919-928) **SHETAN calculation of a cruciform absorber benchmark.** Wong, F.C.; Irish, J.D. (Chalk River Nuclear Labs., Ontario). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

As part of the validation of the SHETAN code for reactivity calculations involving absorbers in light water reactors, a benchmark lattice problem, called the mini-BWR problem, was analyzed. The three-dimensional integral transport code, SHETAN, was used to analyze a numerical benchmark lattice problem consisting of an array of four pin cells with a cruciform absorber in one of the cells. SHETAN can treat problems with mixed rectangular and cylindrical geometries. It also uses a Block Method which allows a reasonable size problem to be solved without having to resort to a very coarse spatial mesh. This method divides a system into rectangular blocks and collision probabilities are calculated within each distinct block type only. All the blocks are linked by the currents at the block interfaces assuming a cosine current distribution.

6647 (NUREG/CP—0080-Vol.2, pp 1033-1040) **Stochastic analysis of mechanical vibrations in reactors.** Taleyarkhan, R.P.; Harris, D.R. Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A FORTRAN code VIBRPI has been developed to compute the generalized cross power spectral density matrix for linear motions of a mechanical system with N connected elements. The code is applied to analysis of the parallel flow and cross flow induced vibrations of BWR instrument guide tubes. The guide tubes, and the neutron detectors contained in them, are regarded as probes to investigate the properties of the flow and the mechanical system. The computations are compared to noise measurements made on operating BWRs. Added mass and drag coefficients are inferred as are parameters of the cross flow induced effects.

6648 (NUREG/CP—0080-Vol.2, pp 1088-1100) **Utility perspective on the use of neutron noise analysis.** Horne, G.P. (Design Engineering Dept., Charlotte, NC). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

Neutron noise analysis is a proven means of studying reactor internals vibration at power. Neutron noise measurements have demonstrated high measurement sensitivity to a variety of internal structural vibrations. It is likely that the sensitivity and accuracy of neutron noise surveillance can be increased through further structural vibration and neutron noise source analysis. Due to its sensitivity to small variations in the mechanical response of the reactor system, neutron noise analysis is capable of being a unique and reliable instrument for excessive vibration, material aging, and structural surveillance of reactor internals. The noise analysis techniques employed by Duke Power personnel can successfully establish the noise characteristics of normal plant operating conditions, recognize noise signature deviation from baseline measurements, and interpret these signatures in regard to the operating environment of the reactor.

6649 (NUREG/CP—0080-Vol.2, pp 1101-1114) **LWR analysis experience with ENDF/B-V data.** Ozer, O. (Electric Power Research Institute, Palo Alto, CA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

An EPRI program for introducing ENDF/B-V based data libraries into LWR design calculations is summarized. This program consisted of evaluating the adequacy of the basic ENDF/B-V data by analyzing simple geometry, clean critical experiments with rigorous methods (Monte Carlo). Following the determination of the general adequacy of the data, the predictions of a more approximate design code, CELL-2, which utilizes ENDF/B-V in a preprocessed, multigroup form have been reconciled with those of the rigorous methods for numerical benchmarks typical of a range of LWR pin cells. The enhanced CELL-2 code was then shown to produce good results for a range of experiments typically utilized for validating LWR design codes. Preliminary comparisons with operating reactor data have also shown ENDF/B-V based calculations to be more accurate in predicting core characteristics.

6650 (NUREG/CP—0080-Vol.2, pp 1115-1126) **New data and methods for CASMO and SIMULATE.** Edenius, M.; Smith, K.S.; Ver Planck, D.M.; Ahlin, A.; Jernberg, P. (Studsvik of America, Newton, MA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The complexity of modern LWR fuel assembly and core designs and the desire for more accurate analysis methods have necessitated continued advancements of the Studsvik CAMSO and SIMULATE core analysis codes. This paper describes recent modifications to the CASMO nuclear data library and the extensive analysis of PWR and BWR benchmark critical assemblies which have verified the accuracy of the data and methods. A new baffle/reflector model incorporated in CASMO-3 is described, and numerical tests of the model are presented. A difficult series of BWR cold shutdown experiments are analyzed using CASMO-3/SIMULATE-3. These experiments demonstrate the high degree of accuracy that can be obtained with the explicit two-group nodal method that uses the discontinuity factors generated by CASMO-3.

6651 (NUREG/CR—4667-Vol.2) **Environmentally assisted cracking in light water reactors. Semiannual report, October 1985-March 1986. Volume II.** Shack, W.J.; Kassner, T.F.; Maiya, P.S.; Park, J.Y.; Ruther, W.E. (Argonne National Lab., IL (USA). Materials and Components Technology Div.). Jul 1986. Contract W-31-109-ENG-38. 63p. (ANL—86-37-Vol.2). NTIS, PC A04/MF A01 - GPO. File Number TI87000853.

This progress report summarizes work performed by Argonne National Laboratory on environmentally assisted cracking in light water reactors during the six months from October 1985 to March 1986.

## 2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

*REFER ALSO TO CITATION(S) 6645, 6646, 6649, 6650, 6651, 6682, 6689, 6693, 6705, 6706, 6707, 6708, 6709, 6710, 6711, 6712, 6713, 6715, 6717, 6721, 6722, 6723, 6724, 6726, 6727, 6728, 6729, 6730, 6731, 6733, 6736, 6737, 6738, 6741*

6652 (CEA-CONF—8379) **Confusion errors and false manoeuvres at power buses.** Cernes, A. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Sep 1985. 14p. (CONF-850989—1; CEA-DAS—197). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750282.

From Technical committee on the assessment of incidents in nuclear power plants; Vienna, Austria (17 Sep 1985).

The incident at Bugey 5 on 14th April 1984, which is regarded as one of the most important in recent years has alas shown again that unless dealt with by the operators in good time, failure of a rectifier supplying one of the buses may soon lead to a very serious situation, in this particular instance voltage loes on the train A 48 volt supply from the two offsite electrical sources and train A diesel generator. Operating experience feedback of the past three years reveals that although the Bugey incident is undoubtedly the most serious, it is not the only where a major alarm was not taken into consideration until fairly late by the operators, and other types of error with far from negligible consequences have occurred during repair work on buses. After a brief reminder of the role and layout of buses, statistics of all incidents of this type in recent years are described and a few cases are presented in order to give some idea of the range of situations encountered. The main measures aimed at reducing the number of incidents of this type are then presented, bearing in mind that one cannot hope to remove the possibility of this type of failure entirely. It may also be noted that the large number of such errors during the night shift or at the very beginning of the morning shift is no doubt connected with the well-known fact that operators are less vigilant at such times.

6653 (CEA-CONF—8434) **Study of a PWR component cooling water system by the disco methodology.** Coudray, R.; Duchemin, B.; Villeneuve, M.J. de. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 10p. (CONF-8604265—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750266.

From 5. EuReData conference on reliability data collection and use in risk availability assessment; Heidelberg, F.R. Germany (9 Apr 1986).

The DISCO (Determination of Importance Sensitivity of Components) method objective is to rank the components of a system. Such ranking is important to answer many questions on availability, maintenance..., for instance to look for: the best component to improve for availability, the first component to repair in case of system failure, and so on. This method was described at the 4th Euredata Conference. Since then it was extended first by including a Failure Mode and Effect Analysis to provide suitable inputs to the second step in the form of fault-trees and eventually Markov graphs, second by applying some importance technique to Markov description. This method was applied, in particular, to the study of a PWR Component Cooling Water System, connected to the Residual Heat Removal System, using the SRDF (Systeme de Recueil de Donnees de Fiabilite) data. Due to several redundancies this system has degraded situations and different working conditions. For these reasons this study implies the generalisation of the method to Markov graphs. The influence of other coupled systems on the results was also studied.

6654 (CEA-CONF—8472) **Corrosion product solubility in the PWR primary coolant.** Lambert, I.; Lecomte, J.; Beslu, P.; Joyer, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Oct 1986. 3p. (CONF-861013—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750230.

From 4. international conference on water chemistry of nuclear reactor systems; Bournemouth, UK (13 Oct 1986).

The solubility of main corrosion products encountered in PWR primary circuits (magnetite and nickel ferrite) was determined between 250 and 350°C. It was found that, in the prevailing primary circuit chemical conditions, the solubilities of magnetite and nickel ferrite are at a minimum as predicted by the POTHY code at temperatures around 300°C. The consequences of the position of this minimum and of the algebraic value of the slope as a function of temperature on the reactor contamination and on the personnel irradiation are studied with the aid of the PACTOLE code. An attempt to determine the best range of pH for the primary coolant conditionning is performed.

6655 **(EPRI-NP—4831) Use of Pourbaix diagrams to infer local pitting conditions.** Daniel, P.L.; Harper, S.L. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.). Oct 1986. 41p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920091.

Corrosion products identified on Alloy 600 tubes pulled from the Millstone Unit 2 nuclear steam generator were compared to phase fields of appropriate Pourbaix diagrams. The diagrams were constructed using new thermodynamic data. They were used to analyze local corrosive conditions and corrosion processes that occur in the steam generators. Indications are that the pH within the pits and wastage areas ranges from 1 to 4 - the higher pH occurs at the tube surface and in pits near the tubesheet; the lower pH occurs in pits away from the tubesheet. The wastage band near the tubesheet is attributed to active dissolution of Alloy 600, which occurs at low potentials. Pitting occurs in areas where reduction of copper oxides raises the Alloy 600 surface potential into the passive range. Local solute concentrations of 0.001 to 0.1 molar are consistent with the postulated pH. This work corroborates the postulated pitting mechanism and suggests a mechanism of formation for the observed wastage bands. It also indicates the need to minimize accumulation of copper and iron oxides and of acid-forming salts in the steam generators.

6656 **(FRADOC—5-3) Seismic design of piping systems.** Anglaret, G.; Beguin, J.L. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 14p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750235.

This paper deals with the method used in France for the PWR nuclear plants to derive locations and types of supports of auxiliary and secondary piping systems taking earthquake in account. The successive steps of design are described, then the seismic computation method and its particular conditions of applications for piping are presented. The different types of support (and especially seismic ones) are described and also their conditions of installation. The method used to compare functional tests results and computation results in order to control models is mentioned. Some experiments realised on site or in laboratory, in order to validate models and methods, are presented.

6657 **(FRADOC—5-4) Seismic analysis of the reactor coolant system of PWR nuclear power plants.** Borsoi, L.; Sollogoub, P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 15p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750234.

For safety considerations, seismic analyses are performed of the Reactor Coolant System (R.C.S.) of PWR Plants. After a brief description of the R.C.S. and R.C.S. operation, the paper presents the two types of analysis used to determine the effect of earthquake on the R.C.S.: modal spectral analysis and nonlinear time history analysis. The paper finally shows how seismic loadings are combined with other types of loadings and illustrates how the consideration of seismic loads affects R.C.S. design.

6658 **(FRADOC—5-7) Dynamic studies of a PWR steam generator tube bundle.** Queval, J.C.; Gantenbein, F.; Alliot, P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 7p. (CONF-850809—83). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750231.

From 8. international conference on structural mechanics in reactor technology; Brussels, Belgium (19 Aug 1985).

Tests have been performed on a reduced scale mock up of a steam generator tube bundle in order to validate a dynamic calculation model for seismic analysis. After presentation of the mock-up, the main test results are given and the calculation model is detailed. A comparison is made on natural frequencies, mode shapes and loads on the support system.

6659 (N—86-30160, pp vp) **Vertical reactor coolant pump instabilities.** Jones, R.M. Dec 1985. NTIS, PC A21/MF A01. (NASA-CP—2409; E—2652; NAS—1.55:2409).

From Instability in Rotating Machinery; Carson City, NV, USA (10 Jun 1985).

The investigation conducted at the Tennessee Valley Authority's Sequoyah Nuclear Power Plant to determine and correct increasing vibrations in the vertical reactor coolant pumps is described. Diagnostic procedures to determine the vibration causes and evaluate the corractive measures taken are also described.

6660 (NUREG/CP—0080-Vol.2, pp 896-906) **Impact of moderator history on physics parameters in pressurized water reactors.** Mosteller, R.D. (S. Levy Inc., Campbell, CA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The magnitude of differential reactivity effects which result from spectral differences in different portions of a PWR core is studied, and it is shown that these effects can be correlated very well with the local moderator history. The impact of these differences on physics parameters such as axial offset, isothermal moderator temperature coefficient, and differential control rod worth is shown to be significant for two PWR's of considerably different design: Zion unit 2 and Arkansas unit 1.

6661 (NUREG/CP—0080-Vol.2, pp 1011-1020) **Predictive maintenance techniques applied to reactor surveillance.** Robinson, J.C.; Mobley, R.K.; Nelson, R.H.; Stevens, J. (Technology for Energy Corp., Knoxville, TN). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

Routine Power Spectral Density Analysis of the Maine Yankee PWR reactor has been carried out on a routine basis since September 1983. The routine (monthly to quarterly) analysis, using data from four excore power range monitors, includes data from two partial and one complete fuel cycles. The data includes the behavior of the PSDs relative to fuel burnup (decreasing boron concentrations) and fuel cycle stretch-out. The general characteristics observed in the spectral densities were identified and trended over a period of time using extensive 2-channel cross correlation analysis techniques. The spectral trends were routinely compared to the initial baseline measurement as well as to general information taken from literature. Predicated on the vast amount of data that must be acquired, analyzed, trended and archived for this type of routine general surveillance, the need for a microprocessor-based data acquisition system and a comprehensive software program specifically developed for Predictive Maintenance monitoring is evident. The utilization of this type of surveillance system would reduce the probability of errors due to manual data acquisition and reduction and the man-hours required by traditional techniques.

6662 (NUREG/CP—0080-Vol.2, pp 1021-1032) **Localization of an excessively vibrating control rod using neutron noise analysis at a pressurized water reactor.** Gloeckler, O.; Por, G.; Valko, J.; Pazsit, I. (Central Research Institute for Physics, Budapest, Hungary). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The purpose of this paper is to discuss some details of a successful localization of a control rod vibration occurring during full power operation of a 440 MWe PWR type reactor. The identification of the vibration and the localization of the vibrating control rod were accomplished as a result of routine in-core neutron noise

measurements using a commercial noise analysis system developed in the Central Research Institute for Physics in Budapest and installed permanently at both Units of the Paks Nuclear Power Plant. Additional noise measurements at full power with different control rod configuration were consequently performed to examine the conditions under which the vibration prevailed. The effect of flow-induced vibration on the neutron noise field was investigated utilizing the spectral functions of the noise signals from standard self-powered neutron detectors. A recently developed localization procedure was used in the localization of the excessively vibrating control rod, demonstrating the capability of the method. This method is incorporated in the Reactor Internals Vibration Monitoring System, being under development at the Central Research Institute for Physics in Budapest. The vibration which occurred near to the end of the fuel cycle, was estimated to be well tolerable. During the refuelling period the suspected control rod was thoroughly examined, evidence of the vibration was found and suspected parts have been replaced. Since then no vibration has been observed.

6663 (NUREG/CP—0080-Vol.2, pp 1041-1052) **Power reactor noise diagnostic methodology for pressurized water reactors.** Wood, R.T.; Perez, R.B. (Univ. of Tennessee, Knoxville). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

In order to better understand the dynamic information available in power reactor noise, a noise diagnostic methodology has been developed and applied using stochastic models based on the physical processes of a reactor system and actual neutron noise data from a pressurized water reactor (PWR) under normal operating conditions. The low frequency (0.001 - 1.0 Hz) behavior of PWR neutron noise is greatly affected by thermal-hydraulic feedback effects and the interrelated energy transport processes of the system. In order to describe the dynamic state of this complicated reactor system, a low-order whole-plant stochastic model was developed to account for the effects of feedback within the system. An expression for the neutron power spectral density (PSD) was obtained by solving the Langevin-type model equations for the Fourier transform of the normalized power fluctuations. This function was fitted to measured PSDs from ex-core detectors at a PWR power plant. Using the results of these fits, the response of the dynamic system to changes in important physical parameters was evaluated by a direct sensitivity analysis. In addition, the effect of such variations in the reactor condition on observable features in neutron noise descriptors was investigated. Using the detection criteria used in current surveillance systems and the sensitivity results of this study, it was possible to relate changes in monitored spectra to changes in physical parameters of the dynamic reactor system in a limited way.

6664 (NUREG/CP—0080-Vol.2, pp 1053-1064) **Stochastic model to monitor vibrations of reactor internals.** Perez, R.B.; Wood, R.T. (Univ. of Tennessee, Knoxville). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

In order to better understand the dynamic information available in power reactor noise, a noise diagnostic methodology has been developed and applied using stochastic models based on the physical processes of a reactor system and actual neutron noise data from a pressurized water reactor (PWR) under normal operating conditions. In the mid-frequency range (1 - 20 Hz), PWR neutron noise is dominated by vibration peaks resulting from the motion of reactor internals. In order to allow a quantitative investigation of the resonance structure of a neutron power spectral density (PSD) and its evolution during a fuel cycle, a resonance model was developed from perturbation theory to give the detector response for small in-core mechanical motions. By mathematically manipulating the model, an equation for the neutron PSD was obtained that describes each motion in terms of a pole-strength factors, a resonance skewness factor, a vibration damping factor, and a frequency of vibration. This formulation allows each resonance peak to be quantified in terms of four identifiable parameters. The model was fitted to measured PSDs obtained from a PWR at various times during a fuel cycle. The mechanical motion parameters for several resonances were tracked to determine trends that indicated changes in vibrations within the reactor core. In addition, the resonance model gave the ability to separate the resonant components of the PSD after the parameters had been identified. As a result, the behavior of several vibration peaks were monitored over a fuel cycle.

6665 (NUREG/CP—0080-Vol.2, pp 1065-1073) **New ways to analyze the fluctuations from reactor systems.** Saxe, R.F. (North Carolina State Univ., Raleigh). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

This paper describes the use of new methods to elucidate the characteristics of PWR internals motion. It uses filtration, autocovariance functions and deconvolution. An approximation to the impulse-response of the internals motion is generated and a time-series representing the motion of the internals, in a chosen frequency band, is also generated. The implications are discussed.

6666 (NUREG/CP—0080-Vol.2, pp 1074-1087) **Reactor sensor surveillance using noise analysis.** Hashemian, H.M.; Thie, J.A.; Upadhyaya, B.R. (Analysis and Measurement Services Corp., Knoxville, TN). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

Reactor noise signals, as measured by neutron detectors and process sensors, contain information about the dynamics of the process and sensor characteristics. The extent of sensor characteristics that can be determined from such measurements depends on the sensor type, the property of the process noise exciting the sensor and its location. This paper addresses degradation monitoring of temperature and pressure sensors, analysis methods and results of application to operating pressurized water reactors. In addition, the use of noise analysis for monitoring of pressure sensing lines in nuclear power plants is discussed.

6667 (SAND—86-0634C) **Life extension research at Sandia National Laboratories.** Bustard, L.D.; DuCharme, A.R. Jr.; DeBey, T.M. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860908—30). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001414.

From Operability of nuclear power systems in normal and adverse environments meeting; Albuquerque, NM, USA (29 Sep 1986).

As part of the Department of Energy (DOE) plant life extension (PLEX) effort, the DOE Technology Management Center at Sandia is actively participating in life extension research efforts. In the areas of reliability and surveillance, systems modelling techniques are being explored to identify those components which, if their reliability changes, could most impact safety. Results of an application of these techniques to the Surry nuclear plant were compared to an industry life extension categorization also performed at Surry. For selected types of components identified during this study, the degradation and failure mechanisms are being explored and state-of-the-art monitoring techniques are being evaluated. Initial results are presented. In the area of cable life extension, a definition study is under way to define utility-specific as well as collective industry actions that would facilitate extending cable life. Some recommendations of this study are also provided.

## 2103 Power Reactors, Non-breeding, Graphite Moderated

*REFER ALSO TO CITATION(S) 6716*

6668 **(CEA-SERMA—16) Parametric study of the low-enriched uranium integrated Fort-Saint-Vrain element; comparative evaluation with the interacting tubular element.** Cerles, J.M.; Carvallo, G.; Vallepin, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Nov 1971. 56p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE87750224.

This paper presents a study of the influence of the different geometric and neutronic parameters on the calculation of the cycle with low-enriched uranium in a Fort-Saint-Vrain type brick. The study is divided in two parts: a stage of physics, essentially neutronics; an economical part where the costs are taken into account. At the level of studies of neutronics and costs, a parallel comparison is developed between the brick Fort-Saint-Vrain and the interacting tubular element, and even thorium. 6 refs. 29 figs.

6669 **(Juel—2046) Examination of several pre-oxidation procedures and their effect as hydrogen permeation-barrier.** Heimes, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Mar 1986. 186p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE87750084.

Several pre-oxidation procedures have been tested with respect to their effect as a hydrogen permeation barrier at the high temperature alloys Hastelloy X and Inconel 617. By outside coating of Hastelloy X samples with alumina the determined impeding effects were very low. A surface aluminium enrichment by different procedures were accomplished before selective oxidation. The method of Aluminium-Hot-Dipping generated oxide layers with a four- to fivefold higher impeding effect compared to specimens fabricated by a standard procedure. With the aid of a metallographical follow-up examination it was shown that the higher impeding effects are due to an improved adhesion between the oxide layer and the high temperature material, whereby in the cooling period after manufacturing a smaller amount of oxide cracking is obtainable.

6670 (NUREG/CP—0080-Vol.2, pp 742-756) **High flux research reactors using particle fuel.** Powell, J.R.; Takahashi, H.; Horn, F.L. (Brookhaven National Lab., Upton, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC02-76CH00016.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

High flux particle bed reactor (HFPBR) designs based on high temperature gas reactors (HTGR) particulate fuel are described. The coated fuel particles, ~ 500 microns in diameter, are packed between porous metal frits, and directly cooled by flowing $D_2O$. The large heat transfer surface area in the packed bed, ~ 100 $cm^2/cm^3$ of volume, allows high power densities, typically 10 MW/liter. Peak thermal fluxes in the HFPBR are 1 to 2 x $10^{16}$ $n/cm^2$ sec., depending on configuration and moderator choice with beryllium and $D_2O$ moderators yielding the best flux performance. Spent fuel particles can be hydraulically unloaded every day or two and fresh fuel reloaded. The short fuel cycle allows HFPBR fuel loading to be very low, ~ 2 kg of $^{235}U$, with a fission product inventory one-tenth of that in present high flux research reactors. The HFPBR can use partially enriched fuel, 20% $^{235}U$, without degradation in flux or reactivity.

## 2104 Power Reactors, Non-breeding, Otherwise Moderated Or Unmoderated

6671 (NUREG/CP—0080-Vol.2, pp 884-895) **Calculation of 3-D flux distributions in CANDU reactors using lattice properties dependent on several local parameters.** Rouben, B.; Brunner, K.S.; Jenkins, D.A. (Atomic Energy of Canada Ltd., Mississauga, Ontario). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A refinement is proposed to the current method of evaluating lattice properties for use in calculations of CANDU flux distributions. This refinement, labelled the local-parameter calculation, takes into account locally appropriate values of coolant density, fuel temperature, and flux/power level where core-average values were previously used. The local-parameter calculation has been implemented and tested. Results are compared to those of previous calculations and of independent methods based on in-core measurements.

## 2105 Power Reactors, Breeding

*REFER ALSO TO CITATION(S) 6689*

6672 **(CEA-CONF—8386) MIR: an in-service inspection device for Superphenix 1 vessels.** Asty, M.; Ceccato, S.; Lerat, B.; Viard, J.; Saglio, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Jun 1986. 8p. (CONF-860603—10). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750268.

From 4. European nuclear conference and 9. FORATOM congress (ENC '86) and international nuclear trade fair; Geneva, Switzerland (1 Jun 1986).

The main and safety vessels of SUPERPHENIX 1 were designed to allow in-service inspections. The remote controlled inspection device MIR was developed for this purpose. It allows both visual and ultrasonic examinations to be performed. Basically, MIR consists of a tetrahedral structure provided with four steering and traction wheels, two for each vessel. A computer assisted control system enables it to be driven to any position on either the main or safety vessels. Operating conditions are briefly reviewed and the main features of MIR presented.

6673 **(CEA-CONF—8426) Uranium-plutonium mixed oxide fuel fabrication. The Super-Phenix core fabrication industrial experience.** Rotoloni, P.; Heyraud, J.; Masselot, Y. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Jun 1986. 12p. (CONF-860608—8). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750050.

From World congress on high tech ceramics: electronic, engineering, nuclear, biomedical research and applications in focus; Milan, Italy (23 Jun 1986).

The reactor fuel of Super Phenix was fabricated at the Fuel Fabrication Complex of Cadarache (CFCA), now jointly exploited by the "Commissariat a l'Energie Atomique" (CEA) of France, and the "Comitato Nazionale per la Ricerca e lo Sviluppo dell'Energia Nucleare e delle Energie Alternative" (ENEA) of Italy. This fabrication campaign represents the most important plutonium fuel manufacturing experience made in the world up to day: 410 fuel assemblies, containing about 42 tons of uranium-plutonium mixed oxide fuel, were manufactured. A quality control plan embracing each single fabrication step secured the respect of product specifications (pellets, pin, sub-assemblies). The manufacturing experience gained encompasses chemical treating and conditioning of production scraps and alpha-contaminated wastes generated during the fabrication campaign.

6674 **(CEA-CONF—8436) Creep design rules in french "RCC-MR" code.** Roche, H.; Delbecq, J.M.; Dubray, B.; Forgeron, T. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 11p. (CONF-8604230—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750267.

From International conference on CREEP; Tokyo, Japan (14 Apr 1986).

In this paper, four points enlightening the originality of the "RCC-MR" analysis rules in the creep range will be discussed. The three first points will concern elastic analysis, the fourth one materials data. The rules given in this paper are applicable for class 1 components and level A conditions. They are given by way of illustration in a simplified form.

6675 **(FRNC-TH—2387) Study of the reactivity effect of sodium voiding in fast-neutron critical experiments. Application to power reactors.** Rimpault, G. (Aix-Marseille-1 Univ., 13 - Marseille (France)). Dec 1979. 327p. (In French). NTIS (US Sales Only), PC A15/MF A01. File Number DE87750281.

A physical explanation is given for the usual decomposition (central component and leakage component) by means of the perturbation theory in the diffusion theory. The important characteristics of the effect of sodium voiding are pointed out with regard to the space, the spectrum, and the concentrations of the different elements present in the medium studied. The thesis deals also with experimental programmes: experimental techniques and incertainties of measurements, and experimental values obtained from the cores. The problems of method are dealt with, from the reference method to the proposed method. The validity of the approximations of the calculation method are dealt with: 1) influence of the definition method for the multigroup cross sections on the central component; 2) heterogeneous effects of the cell; 3) evaluation of the transport correction with regard to the approximation of the diffusion. The influence of the set of cross sections on the sodium-voiding effect is studied. Finally, a comparison between experiment and calculation is carried out.

6676 (NUREG/CP—0080-Vol.2, pp 844-870) **Physical studies on a plutonium fueled spectral shift reactor via perturbation methods.** Vallee, A.; Bruna, G.B.; Gonse, E.; Legendre, J.F.; Doriath, J.Y.; Porta, J. (Framatome, Paris, France). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

In the framework of the neutronic studies on the FRAMATOME advanced plutonium fueled RCVS reactor, analysis were made in order to appreciate the main physical feature of the model. During these studies, perturbation techniques were widely used as a major investigation tool. The authors present, in this paper, some ideas dealing with the definition of two few group energy structures adapted to project calculations, and a general overview on some reactivity related phenomena as the burn-up, breeding process, the control rod insertion and the power, temperature effects. A preliminary study on the way to approach spectral shift by perturbation is also presented.

6677 (NUREG/CP—0080-Vol.2, pp 1157-1169) **Local heterogeneity effects on small-sample worths.** Schaefer, R.W. (Argonne National Lab., Idaho Falls, ID). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract W-31-109-ENG-38.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

An ideal technique for measuring small-sample worths would introduce the sample without otherwise disturbing the core unit cell. The standard technique used in ANL fast reactor critical experiments entails several distortions to the unit cell (local heterogeneities) that currently must be neglected in calculations. A large set of experiments is presented that were designed to determine how large the neglected local heterogeneity effects are. The experiments show that the size of the effects varies with sample type and reactor type. Fissile sample worths are affected by up to 6%, which accounts for a significant portion of the long standing central worth discrepancy.

## 2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

6678 **Some thoughts on the commercial use of reactors in space.** Buden, D.; Lee, J. (Science Applications International Corp., Albuquerque, NM 87102). pp 1980-1984 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The purpose of this paper is to illuminate the major regulatory issues associated with commercialization of space nuclear power. Currently, space reactors are government-owned and approved through the Interagency Nuclear Safety Review Panel (INSRP) and the President while commercial reactors are licensed by the Nuclear Regulatory Commission. The commercial use of reactors in space will open a new regime of regulation; that is public intervenors could enter the space licensing process for the first time. The major issue is responsibility for licensing and operations, but related considerations involve controlling special nuclear materials from aborted launches or abandoned platforms, determining final shutdown and disposal tactics, and solving new design issues such as the need for longer life of space reactor power plants.

6679 **The use of nuclear energy for bimodal applications in space.** Horn, F.L.; Powell, J.R.; Ludewig, H. (Brookhaven National Lab.). pp 1849-1853 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—). Contract AC02-76CH00016.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The versatile bimodal nuclear reactor is proposed for producing space station-keeping power of 100's kW and also capable of bursts of power by ramping to 100's MW for short times to operate high power magnetic systems. The particle bed reactor, using half-millimeter diameter fuel particles immersed in coolant, provides the heat transfer capability needed for this power level. The coolant is a gas when directly coupled to a Brayton Cycle and is particularly responsive. The reactor design uses 37 fuel elements in a triangular pattern held in a cylindrical core. The reactor, radiator and turbogenerator are packaged for insertion into the shuttle cargo bay.

6680 **Compatibility studies on SP-100 fuel, cladding and lithium.** Lundberg, L.B. (Los Alamos National Lab., Los Alamos, NM 87574). pp 1944-1949 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Experiments have been performed to study the reactions between liquid lithium and UN fuel materials at temperatures comparable to those expected in the core of an SP-100 reactor. Solid fuel was sealed in containers of either pure molybdenum or Nb-1Zr along with lithium, and each assembly was heated in a vacuum. UN did not disintegrate in lithium contained in either molybdenum or Nb-1Zr even after exposures to temperatures up to 1525 K for time to 620 h. However, changes in microstructure and nitrogen concentration indicated that N/U was reduced in Nb-1Zr capsules while the N/U increased in molybdenum containers. UN and Nb-1Zr appeared to achieve the predicted chemical equilibrium relative to nitrogen in the 1525 K experiment. Uranium from the UN was found to be diffused only into Nb-1Zr in a manner similar to previous observations in the UN/W/Nb-1Zr system.

6681 **Nuclear alkali metal Rankine power systems for space applications.** Moyers, J.C.; Holcomb, R.S. (Oak Ridge National Lab., Oak Ridge, TN 37831). pp 2094-2099 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Nuclear power systems utilizing alkali metal Rankine power conversion cycles offer the potential for high efficiency, lightweight space power plants. Conceptual design studies are being carried out for both direct and indirect cycle systems for steady state space power applications. A computational model has been developed for calculating the performance, size, and weight of these systems over a wide range of design parameters. The model is described briefly and results from parametric design studies, with descriptions of typical point designs, are presented in this paper.

### 2107 Regulation And Licensing

*REFER ALSO TO CITATION(S) 6678*

6682 **(CEA-CONF—8303) French regulatory practice and its evolution.** Dupraz, B.; Dupuis, M.C.; Lebouleux, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Mar 1985. 17p. (In French). (CONF-8503261—1; CEA-DAS—198). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750271.

From International symposium on advances in nuclear power plant availability, maintainability and operation; Muenchen, F.R. Germany (20 Mar 1985).

Involvement of governmental authorities in nuclear safety takes three main forms: licensing and follow-up procedures, monitoring and general technical regulations. In accordance with licensing and follow-up procedures, three main permits are required for each plant: permits for construction, for startup and for starting normal operation. The nature of the French nuclear power programme, under which series of identical PWR units are constructed, has led to the adaptation of these procedures by making use of standardization; by examining, at the earliest stage for a new reactor type, the safety options for that type; and by continuous follow-up of operating reactors as regards work programmes foreseen for refuelling outages, safety modifications and significant incidents. Monitoring activities have seen a considerable expansion as a result of the increase in the number of operating reactors and have to a large extent been decentralized among the regional organizations of the ministry responsible for industry: their effectiveness is largely attributable to plant standardization. General technical regulations have developed progressively, in particular on the basis of technical analyses performed in the context of licensing procedures. The regulatory system elaborated by the governmental authorities is complemented by collections of design and construction regulations, which constitute sets of codes and standards proposed by the operator under his own responsibility.

## 22 NUCLEAR REACTOR TECHNOLOGY

### 2201 Theory And Calculation

6683 (NUREG/CP—0080-Vol.2, pp 907-918) **DANDE-a linked code system for core neutronics/depletion analysis.** LaBauve, R.J.; England, T.R.; George, D.C.; MacFarlane, R.E.; Wilson, W.B. (Los Alamos National Lab., NM). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

This report describes DANDE-a modular neutronics, depletion code system for reactor analysis. It consists of nuclear data processing, core physics, and fuel depletion modules, and allows one to use diffusion and transport methods interchangeably in core neutronics calculations. This latter capability is especially important in the design of small modular cores. Additional unique features include the capability of updating the nuclear data file during a calculation; a detailed treatment of depletion, burnable poisons as well as fuel; and the ability to make geometric changes such as control rod repositioning and fuel relocation in the course of a calculation. The detailed treatment of reactor fuel burnup, fission-product creation and decay, as well as inventories of higher-order actinides is a necessity when predicting the behavior of the reactor fuel under increased burn conditions. The operation of the code system is illustrated in this report by two actual problems.

6684 (NUREG/CP—0080-Vol.2, pp 1170-1178) **Measurement of the fission cross section of $^{238}$PU.** Alam, B.; Block, R.C.; Slovacek, R.E.; Hoff, R.W. (Rensselaer Polytechnic Institute, Troy, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The fission cross section of $^{238}$Pu has been measured from 0.1 eV to 80 keV energy range using the Rensselaer Intense Neutron Spectrometer. The cross section was normalized to the $^{235}$U ENDF/B-V data broadened to the resolution of the Rensselaer Intense Neutron Spectrometer system. The fission areas and widths were determined for the resolved low-energy resonances. The ENDF/B-V fission cross section for the $^{238}$Pu isotope are, in general, not in good agreement with the measured cross section and a new evaluation is recommended. The observation of structure in the unresolved fission cross section is suggestive of the existence of intermediate structure.

6685 (NUREG/CP—0080-Vol.2, pp 1179-1187) **Average prompt neutron emission multiplicity (Nubar) values at 2200 meters per second for the fissile nuclides.** Holden, N.E.; Zucker, M.S. (Brookhaven National Lab., Upton, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC02-76CH00016.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The prompt neutron emission multiplicity distribution, P/sub upsilon/, and its average value, <upsilon>, (i.e. nubar) have been determined at the standard neutron energy of 0.0253 ev for the neutron induced fission of the four fissile nuclides, /sup 233,235/U, and /sup 239,241/Pu. Revised values of <upsilon> have been obtained by re-evaluating <upsilon> experiments measured at 2200 meters/second relative to the <upsilon> from the spontaneous fission of $^{252}$Cf. These revised values of <upsilon> have been used to renormalize the measured P/sub upsilon/ values. The revised values of <upsilon> are all about 1/4% to 1/3% smaller than the corresponding values of ENDF/B-V.

### 2202 Components And Accessories

*REFER ALSO TO CITATION(S) 6659, 6714*

6686 **(CEA-CONF—8377) Truly unconfined deflagrations of ethylene-air mixtures.** Di Fabio, N.; Garnier, J.L. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Aug 1985. 23p. (In French). (CONF-850830—10; CEA-DAS—182). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750284.

From 10. international colloquium on dynamics of explosions and reactive systems; Berkeley, CA, USA (4 Aug 1985).

To estimate the possible over-pressure on the structures of a nuclear power plant under an external explosion, studies on unconfined explosions to provide the necessary elements to establish a safety rule, have been developed. The present research contract, carried out by a French group CEA-EDF-ENSMA, was divided in four stages: 1) Scale effect on the pressure field produced by spontaneous accelerations on blasts in an steady medium; 2) effect of a brutal discontinuity of the fuel gas concentration on the blast speed in a stratified medium; 3) effect of the blast-off energy on the explosion of a spherical ethylene-air mixture; 4) study of the influence of the shape and of the size of the cloud on the pressure field produced by the explosion.

6687 **(FRADOC—5-1) Earthquake protection of essential civil and industrial equipments.** Bourrier, P.; Le Breton, F.; Thevenot, A. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 12p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750237.

This document presents the principal reflexions concerning seismic engineering applications for equipment and the difference of the non-employment towards these structures. The notion of essential equipment is then pointed out as well as the main particularities of equipment considered as structures. Finally, this document illustrates a few pathological examples encountered after an earthquake, and presents some equipments of a nuclear power plant which to resist an increased safety seism.

6688 **(FRADOC—5-2) Analysis of structures subjected to multiple spectra input.** Rigaudeau, J.; Sollogoub, P. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 13p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750236.

Spectral analysis is currently used in the study of the response of structures under seismic excitation. It may be that the characteristics of the excitation, represented by oscillator response spectra, vary from a support to another one. In industrial plants, e.g. in nuclear power plants, this situation occurs more particularly for pipes or high equipments. Spectral analysis is extended to multiple support excitation by considering the relative motion with respect to the instantaneous static ("pseudo static") response, which is no longer a rigid body motion. A complementary static analysis is therefore introduced, but spectral analysis can be performed under similar conditions to that of uniform excitation. The correction for rigid modes is also considered, as well as the influence of multiple excitation on time history analysis.

6689 **(FRADOC—5-5) Validation tests of models and methods used for calculation of mechanical equipments.** Buland, P.; Lasne, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 18p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750233.

Safety rules applied to the nuclear field require to take into account low-probability risks such as the seismic risk. This chapter deals with problems associated with seismic tests performed to validate calculation models and methods. After recalling the necessity of such tests, the methods (modal analysis) and facilities used are described. A paragraph deals more specifically with reduced scale testing before presenting some test examples and their interpretation by calculation models.

6690 (N—86-30160, pp vp) **Cracked shaft detection on large vertical nuclear reactor coolant pump.** Jenkins, L.S. Dec 1985. NTIS, PC A21/MF A01. (NASA-CP—2409; E—2652; NAS—1.55:2409).

From Instability in Rotating Machinery; Carson City, NV, USA (10 Jun 1985).

Due to difficulty and radiation exposure associated with examination of the internals of large commercial nuclear reactor coolant pumps, it is necessary to be able to diagnose the cause of an excessive vibration problem quickly without resorting to extensive trial and error efforts. Consequently, it is necessary to make maximum use of all available data to develop a consistent theory which locates the problem area in the machine. This type of approach was taken at Three Mile Island, Unit # 1, in February 1984 to identify and locate the cause of a continuously climbing vibration level of the pump shaft. The data gathered necessitated some in-depth knowledge of the pump internals to provide proper interpretation and avoid misleading conclusions. Therefore, the raw data included more than just the vibration characteristics. Pertinent details of the data gathered is shown and is necessary and sufficient to show that the cause of the observed vibration problem could logically only be a cracked pump shaft in the shaft overhang below the pump bearing.

## 2203 Fuel Elements

*REFER ALSO TO CITATION(S) 7218*

## 2204 Control Systems

6691 **(Juel—2051-Trans.) Combined thermocouple-noise thermometry.** Brixy, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Apr 1986. 46p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87750081.

The combined thermocouple-noise thermometer (TC-NT) unites the advantages of the thermocouple (simple measuring procedure, high sensitivity) with those of the noise thermometer (no decalibration, high absolute accuracy). With the combined thermometer, the TC in the sensor can be calibrated insitu. The advantage of this in situ calibration is that also all parasitic thermovoltages from inhomogeneous thermocouple wires in temperature gradients are calibrated and thus no measurement error arises. With the combined thermometer it is now possible for the first time to detect and eliminate in practice inhomogeneity errors (drifts). In order to clarify understanding of the basic effects, the modern theory of the thermocouple (generation of thermovoltage in the wires only in temperature gradients) is described as well as the principles of noise thermometry.

## 2205 Environmental Aspects

*REFER ALSO TO CITATION(S) 7364, 7365, 7409*

6692 **(CEA-DPS—85-07) Population distribution around French nuclear sites.** Bastien, M.C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection Sanitaire). Oct 1985. 219p. (In French). NTIS (US Sales Only), PC A10/MF A01. File Number DE87750276.

With the help of two files respectively from the Institut geographique national (IGN) containing the geographic reference of all cities in France, and from the Institut national de la statistique et des etudes economiques (INSEE) containing the population figures of the 1982 census, the distribution of the population around a geographic point can be determined according to a given grid. Tables of population distribution around the 30 french nuclear sites were obtained by this method; however, at a short distance from a site, a detailed local examination/survey/investigation is necessary. Data shall have to be collected to estimate the non-french population around frontier sites.

6693 **(NUREG—1171-Final) Final environmental statement related to the operation of South Texas Project, Units 1 and 2 (Docket Nos. 50-498 and 50-499).** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Aug 1986. 383p. NTIS, PC A17/MF A01 - GPO. File Number TI86901753.

This Final Environmental Statement contains the second assessment of the environmental impact associated with the operation of the South Texas Project, Units 1 and 2, pursuant to the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations, Part 51, as amended, of the Nuclear Regulatory Commission regulations. This statement examines the environmental impacts, environmental consequences and mitigating actions, and environmental and economic benefits and costs associated with station operation. Land use and terrestrial and aquatic ecological impacts will be small. No operational impacts to historic and archeological sites are anticipated. The effects of routine operations, energy transmission, and periodic maintenance of rights-of-way and transmission facilities should not jeopardize any populations of endangered or threatened species. No significant impacts are anticipated from normal operational releases of radioactivity. The risk of radiation exposure associated with accidental release of radioactivity is very low. Socioeconomic impacts of the project are anticipated to be minimal. The action called for is the issuance of an operating license for South Texas Project, Units 1 and 2.

## 2206 Research, Test, And Experimental Reactors

*REFER ALSO TO CITATION(S) 6701, 6725*

6694 (EGG-EA—7521) **Initial characterization of the ATR [Advanced Test Reactor] Large Gamma Facility.** Schnitzler, B.G.; Rogers, J.W. (EG and G Idaho, Inc., Idaho Falls (USA)). May 1986. Contract AC07-76ID01570. 43p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87001429.

Radiation fields in the ATR Large Gamma Facility test volume are characterized. The preliminary characterization efforts described in this report include total dose rate measurements in the facility, development of a simple methodology for calculating radiation fields from the ATR fuel element power histories, and a comparison of the measured and calculated values.

6695 (NUREG/CP—0080-Vol.2, pp 757-768) **Safety and licensing aspects of the MAPLE-X reactor at the Chalk River Nuclear Laboratories.** Cotnam, K.D. (Chalk River Nuclear Labs., Ontario). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A new facility based on the MAPLE research reactor concept is being planned for the Chalk River Nuclear Laboratories in Canada. The reactor with be used primarily for the production of short lived radioisotopes and will also serve as a prototype of a MAPLE research reactor.

6696 (NUREG/CP—0080-Vol.2, pp 792-809) **Intense steady state neutron source - the CNR reactor.** Difilippo, F.C.; Moon, R.M.; Gambill, W.R.; Primm, R.T. III; West, C.D. (Oak Ridge National Lab., TN). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC05-84OR21400.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The Center for Neutron Research (CNR) has been proposed in response to the needs - neutron flux, spectrum, and experimental facilities - that have been identified by the neutron scattering, isotope, and materials irradiation research communities through workshops, studies, and discussions. The CNR is a major new experimental facility consisting of a reactor-based steady state neutron source of unprecedented flux, together with extensive facilities and instruments for neutron scattering, isotope production, materials irradiation, and other research areas.

6697 (NUREG/CP—0080-Vol.2, pp 810-820) **Designing CNR, a very high thermal neutron flux facility.** Difilippo, F.C. (Oak Ridge National Lab., TN). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC05-84OR21400.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

According to a recent study (Eastman-Seitz Committee, National Academy of Science) there is a need for a new generation of steady neutron sources with a thermal neutron flux peak between 5 to 10 times $10^{15}/cm^2$ sec. Ideally the neutron source would have to operate continuously for several days (two weeks at least) with minimum time (2-3 days) for refueling and/or maintenance and it would also be used to irradiate materials and produce isotopes. This paper describes the preliminary design of the nuclear reactor for the proposed Center for Neutron Research (CNR). A duplication of existing designs (HFIR, (ORNL), ILL (Grenoble, France)) would imply high total power and small core life; the necessity of high efficiencies (in terms of peak-flux-per-unit source or power) then becomes apparent. The authors have found analytical expressions for the efficiency in terms of a few parameters such as the volume of the source and the Fermi age and diffusion length of thermal neutrons in both the source and reflector regions. A single analytical expression can then be used for scoping the design and to intercompare radically different designs. Higher efficiencies can be achieved by reducing the volume and the moderation of a core immersed in a very low absorbing reflector; on the contrary a very long core life has a negative effect on the efficiency at beginning of life. Consequently, and after detailed calculations, the authors have found a candidate design with the following characteristics: core, $U_3Si_2$, 93% enriched, 18.1-kg $^{235}U$, metal fraction 50%, Al cladding, and 35-L volume; reflector and moderator, $D_2O$; efficiency at end of life (EOL) with respect to the ILL reactor, 1.29; flux at EOL, 10 x $10^{15}/cm^2$ sec (power in core 270. MW); core life, 14 days burnup 28.4%.

6698 (NUREG/CP—0080-Vol.2, pp 821-831) **Burnup and flux control measures for the safe operation of the 23 MW research reactor DIDO during core degrading.** Nabbi, R.; Bormann, H.J.; Kalker, K.J. (Kernforschungsanlage Juelich, West Germany). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A computer-aided control method for the safe operation of 23 MW research reactor DIDO during the core conversion from highly enriched uranium fuel (HEU: 80%) to low enriched uranium fuel (LEU: 20%) is represented. On the basis of the foil activity measurement along the fuel elements the code CREMAT allows the evaluation of the power, neutron flux distribution and burnup conditions of the FE. The computational model of the code has been verified by comparative calculation with the code ORIGEN. The results of calculations for the neutron flux and nuclide densities show a maximum deviation of 5.3% between the two codes. After the code verification the operating behavior of the different HEU and LEU fuel elements has been analyzed. The results show that in case of fresh loading and for a given FE power, the nuclear flux diminishes with the increase of the initial fuel density. The replacement of a 150 g HEU fuel element by a 180 g LEU one results in decreasing the thermal neutron flux by 15.5%. Due to the flux behavior the burnup of HEU occurs faster than the LEU fuel resulting in a shorter irradiation time in the core. The time for reaching the burnup limit of 60% amounts to 90.9 and 110.20 days respectively.

6699 (NUREG/CP—0080-Vol.2, pp 832-843) **Two-dimensional cell heterogeneity effect in analysis of fast critical assemblies.** Takeda, T.; Tsujimoto, K.; Unezaki, H.; Yamamoto, T.; Shirakata, K. (Osaka Univ., Japan). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

Two-dimensional (2-D) heterogeneity effects on cell-averaged cross sections and diffusion coefficients have been estimated. Both of the heterogeneity effects caused by the flux fine structure and the resonance shielding are taken into account. The accuracy of several 1-D cell models is assessed by comparing cell parameters obtained from 1-D and 2-D cell calculations. The 2-D cell heterogeneity effects on core performance parameters have been evaluated for the large fast critical assembly ZPPR-9. The Zebra CADENZA plate-pin experiments have been analyzed using the 2-D cell model, the usefulness of the 2-D cell calculation is discussed.

6700 (NUREG/CP—0080-Vol.2, pp 1127-1138) **Determination of large subcriticality by pulsed neutron method for nuclear criticality safety study.** Yamane, Y.; Maki, T.; Yoshida, A.; Nishina, K.; Kobayashi, K. (Nagoya Univ., Japan). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

To establish the method determining large subcriticalities in the field of nuclear criticality safety, the authors performed pulsed neutron experiments using the Kyoto University Critical Assembly (KUCA) and a Cockcroft-Walton type accelerator attached to the assembly. In order to remove a contamination of spatial higher modes from the neutron decay curve, which becomes significant as subcriticality increases, the integral-version of the area-ratio method proposed by Kosaly and fisher was employed to evaluate large subcriticalities. This method has the shortcoming that the delayed neutron component remarkably decreases as the subcriticality of a system increases. To experimentally overcome the shortcoming, the

frequency of pulsed neutron generation was increased up to 240 Hz. The largest subcriticality determined in the present experiments was 73.41 +/- 1.04 dollars, which was equal to 0.6229 +/- 0.0033 in effective multiplication factor k-eff. The theoretical k-eff, on the other hand, was calculated with the Monte-Carlo code KENO-IV with 137 energy groups. The calculational values were slightly smaller than the experimental values. The discrepancy between the experiment and the calculation was approximately 9% at largest, which was for the smallest measured k-eff.

## 2207 Plutonium And Isotope Production Reactors

*REFER ALSO TO CITATION(S) 6696, 6697*

6701 (NUREG/CP—0080-Vol.2, pp 780-791) **Ultrahigh flux double donut research reactor design.** Ryskamp, J.M.; Parsons, D.K.; Lake, J.A. (Idaho National Engineering Lab., Idaho Falls). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC07-76ID01570.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A new steady-state thermal neutron source of unprecedented intensity is under development for materials science research, isotope production, and fundamental physics research. The challenge put forth by the research community is to produce a thermal neutron flux of $10^{16}$ n/($cm^2$s) in a large accessible volume with minimum fast neutron and gamma contamination. Ultrahigh flux reactor designs based on well-characterized plate-fuel technologies have been examined at the Idaho National Engineering Laboratory. A double donut core configuration extends the range of peak operating conditions, which are traditionally limited by fuel plate temperatures and thermal hydraulic conditions in the hot channel, to a point where these flux intensity goals can be attained.

## 2208 Propulsion Reactors

6702 **The PEGASUS drive: A multi-megawatt nuclear electric propulsion system.** Coomes, E.P.; King, D.Q.; Cuta, J.M.; Webb, B.J. (Pacific Northwest Lab., Richland, WA 99352). pp 1856-1861 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—). Contract AC06-76RL01830.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Electric propulsion systems have not been seriously considered for use with large spacecraft due to the lack of suitable electric power source to drive them. However, recent efforts to develop megawatt-class space power sources show such systems to be technologically feasible. A multi-megawatt lightweight nuclear electric power plant driving an electric propulsion system, such as a megawatt class magnetoplasmadynamic (MPD) thruster, would make this quite an attractive propulsion system for extended missions. PEGASUS, a power generating system for use in space, is one such multimegawatt power system that would enable missions of almost any conceivable duration and scope. The PEGASUS Drive is the coupling of this nuclear electric power system with a 6 MWe MPD thruster. The power system has a maximum power output of 8.5 MWe. The MPD thruster requires 6 MWe to provide spacecraft propulsion and 1.5 MWe are available for mission-specific tasks and experiments. The balance of power generated is used to operate the power system. The size and mass limitations of the STS are of prime consideration in the design of this system to allow the collapsed system to be placed in lower earth orbit by two shuttle missions. The main system (19,120 kg) employing a shadow shield would require one launch and the balance of the four-pi shield (27,830 kg) would occupy the second launch. Development of this power system could be completed by the mid 1990's and the system available near the turn of the century.

## 2209 Reactor Safety

*REFER ALSO TO CITATION(S) 6767, 7022, 7500*

6703 (BNL-NUREG—38266) **Analysis of high pressure boil-off situation during MSIV closure ATWS in a typical BWR/4.** Neymotin, L.Y.; Slovik, G.C.; Saha, P. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 17p. (CONF-860610—13). NTIS, PC A02/MF A01 - GPO. File Number TI86013916.

From American Nuclear Society annual meeting; Reno, NV, USA (15 Jun 1986).

The objective of this paper is to provide a best-estimate analysis of the MSIV Closure ATWS in the Browns Ferry Unit 1 BWR with Mark 1 containment. The calculations have been performed using the RAMONA-3B code which has a three-dimensional neutron kinetics model coupled with one-dimensional (multichannel core representation), four-equation, nonhomogeneous, nonequilibrium thermal hydraulics. The code also allows for one-dimensional neutronic core representation. The 1-D capability of the code has been employed in this calculation since a thorough sensitivity study showed that for a full ATWS, a one-dimensional (axial) neutron kinetics adequately describes the core behavior. (Note that the core steady-state symmetry in this case was preserved throughout the transient so that radial effects could be neglected.) The calculation described in the paper was started from a steady-state fuel condition corresponding to the end of Cycle 5 of the Browns Ferry reactor.

6704 (BRAP—86008) **Radioactive fallout caused by the reactor accident at Chernobyl: Observations April-May 1986.** Kresten, P. (Sveriges Geologiska Undersoekning, Uppsala). Jun 1986. 112p. (In Swedish). NTIS (US Sales Only), PC A06/MF A01. File Number DE87750163.

Gamma spectrum of 25 samples has been measured. The release has contained some 30 isotopes. Zr 95, Nb 95, Ru 103, Te 129, Te 131, Te 132, I 131, I 132, Cs 134, Cs 136, Cs 137, Ba 140, La 140 and Ce 141 have been most frequent. Te 132 and/or I 131 have constituted the major part of the enhanced activity, in the areas with increased fallout (G.B.).

6705 (CEA-CONF—8342) **LOFT tests: double-ended break.** Macheteau, Y. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). 1985. 73p. (In French). (CONF-8311295—1). NTIS (US Sales Only), PC A04/MF A01. File Number DE87750225.

From RELAP TRAC seminar; Fontenay-aux-Roses, France (15 Nov 1983).

The aim of these tests is to simulate a double-ended break in the cold leg of a commercial PWR reactor operating at its nominal power. Four tests have been carried out L1-5, L2-2, L2-3, L2-5, for the 3 first ones, pumps have been maintained operating during all the transient; for L2-5, they have been stopped at the beginning of the depressurization and emergency injections have been significantly delayed. Depressurization has been studied with the codes RELAP4, MOD6 and TRAC-PF1; the main results concern: pressure, early rewetting and refill. The study of reflooding has been carried out with RELAP4, MOD6. RELAP4 can be considered as a code with satisfying performance for double-ended break calculations. TRAC-PF1 has the advantage to allow the study of disequilibrium phenomenons between phases.

6706 (CEA-CONF—8344) **LOBI loop.** Pochard, R.; Probst, P.; Sonnet, A.; Tartu, H.; Viviande, M.A.; Giri, A.; Leridon, A.; Le Berre, F. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). 1985. 15p. (In French). (CONF-8311295—2). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750226.

From RELAP TRAC seminar; Fontenay-aux-Roses, France (15 Nov 1983).

This paper presents the LOBI loop (representation of a 4-loops PWR reactor at the scale 1/712): main characteristics and evolution. It allows the study of the phase of depressurization

during a LOCA on the cold, hot or intermediate leg, and the study of the thermal-hydraulic behavior during transient tests.

6707 **(CEA-CONF—8345) LOBI. Large breaks. Experimental program.** Pochard, R.; Probst, P.; Sonnet, A.; Tartu, H.; Viviande, M.A. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). 1985. 25p. (In French). (CONF-8311295—3). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750227.

From RELAP TRAC seminar; Fontenay-aux-Roses, France (15 Nov 1983).

This paper presents graphs of comparison experiment - calculation (code RELAP4-MOD6) for the three following points in the case of a LOCA on the primary circuit: depressurization, first rise of temperature and stagnation point; bypass refilling.

6708 **(CEA-CONF—8346) Reflooding-reflooding calculations CP1 with the aid of RELAP4-MOD6, physical reflooding option.** Probst, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). 1985. 13p. (In French). (CONF-8311295—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750228.

From RELAP TRAC seminar; Fontenay-aux-Roses, France (15 Nov 1983).

This paper deals briefly with heat transfer in the core, the liquid entrainment by steam, and the fluid mass evolution within the core during the reflooding phase.

6709 **(CEA-CONF—8347) Reactor calculations CP1: Design Basis Accident, depressurization, refilling. RELAP4-MOD6, SATAN6, TRAC PF1.** Macheteau, Y.; Menessier, D.; Sauvage, J.Y.; Thibaudeau, J.; Pochard, R.; Trefouret, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). 1985. 34p. (In French). (CONF-8311295—5). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750229.

From RELAP TRAC seminar; Fontenay-aux-Roses, France (15 Nov 1983).

This paper presents results of calculations obtained from the codes TRAC-PF1, RELAP4-MOD6 and SATAN6. After a recall of the different modelling processes, the results are given; they concern: depressurization (pressure evolution, break flow rate); first peak of temperature (fuel can, departure nucleate boiling and stagnation point); by-pass and refilling. Finally, the advantages of TRAC-PF1 are pointed out.

6710 **(CEA-CONF—8375) SB loca research: regulatory application and needs for the future.** Brisbois, J.; Tellier, N. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Jun 1985. 18p. (CONF-850646—10; CEA-DAS—179). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750272.

From 2. international specialists meeting on small break LOCA analysis in LWRs; Pisa, Italy (24 Jun 1985).

Besides the long term safety research whose main purpose is to develop and improve safety analysis tools, the lessons learned from the TMI accident showed that the emphasis should be given on small break analysis, with multiple failures or not, to have a thorough understanding of nuclear power and decay heat removal processes in its many modes in order to develop good plant procedures. The impact of these studies on the design and on the emergency procedures, resulting from the licensing process, are described and the needs for the future are identified.

6711 **(CONF-8610135—3) Examination of the bases for proposed innovations in reactor safety technology.** Moses, D.L. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002184.

From 14. water reactor safety information meeting; Gaithersburg, MD, USA (27 Oct 1986).

This paper employs the criteria for evaluations from the Nuclear Power Option Viability Study to examine the bases for proposed innovations in light water reactor safety technology. These bases for innovation fall into four broad categories as follows: (1) virtually exclusive reliance on passive safety features to preclude core damage in all situations, (2) design simplification using some passive safety features to reduce the frequency of core damage to less than about $10^{-6}$ per reactor-year, (3) passive containment to preclude releases from any accident, and (4) designing to limit licensing attention to one or at least a few systems. Of these, only the first two, and perhaps only the second, hold significant promise for providing for the viability of advanced light water reactors.

6712 **(EGG-M—13185) Effectiveness and safety aspects of selected decontamination methods for LWRS.** Duce, S.W. (EG and G Idaho, Inc., Idaho Falls (USA)). 1985. Contract AC07-76ID01570. 17p. (CONF-8505103—8). NTIS, PC A02/MF A01 - GPO. File Number TI87001443.

From Health Physics Society annual meeting; Chicago, IL, USA (26 May 1985).

Use of chemical reagent systems to remove oxide films in primary coolant system piping was widely performed in US light water reactors in 1984. The principle application of chemical decontamination was in boiling water reactors primary coolant recirculation systems and reactor water cleanup systems prior to inservice inspection and repair of system welds, or major system pipe replacement. A research study, funded by the Nuclear Regulatory Commission (NRC) and performed by EG & G Idaho, Inc., examined the effectiveness of chemical decontamination methods to reduce total man-rem expended to perform the inspection or replacement tasks, and waste volume going to low level waste burial sites. Items evaluated were (a) methods used to determine decontamination factors (DFs), (b) DFs obtained, (c) man-rem savings, (d) waste forms generated, (e) man-rem expended in performing the decontamination, (f) overall operations (i.e., problems and lessons learned, and (g) other items of information that would assist the NRC in their review processes. This paper presents information and results on (a) methods used for determining DFs, (b) actual DFs obtained with chemical decontamination methods, (c) waste forms and volumes generated, and (d) resultant man-rem savings.

6713 **(EGG-TMI—7385) TMI-2 core bore acquisition summary report.** Tolman, E.L.; Smith, R.P.; Martin, M.R.; McCardell, R.K.; Broughton, J.M. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1986. Contract AC07-76ID01570. 173p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87002595.

Core bore samples were obtained from the severely damaged TMI-2 core during July and August, 1986. A description of the TMI-2 core bore drilling unit used to obtain samples; a summary and discussion of the data from the ten core bore segments which were obtained; and the initial results of analysis and evaluation of these data are presented in this report. The impact of the major findings relative to our understanding of the accident scenario is also discussed.

6714 **(FRADOC—5-6) Dynamic study of thin cylindrical vessels.** Alliot, P.; Herrmann; Sollogoub, P.; Queval, J.C.; Gantenbein, F.; Gibert. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). 1986. 5p. (In French). (CONF-860189—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750232.

From 1. national colloquium on paraseismic engineering; Saint-Remy-les-Chevreuse, France (29 Jan 1986).

Fluids essential for the safety of a nuclear reactor (water, boron...) are contained in thin cylindrical vessels. An experimental investigation of the dynamic buckling of a thin cylindrical vessel filled with a fluid has been carried out on a shaking table. An investigation of the frequencies and mode shape of the vessel had also been done prior to the test. Calculations performed in order to predict these frequencies and modes have shown the importance of taking into account the stiffening effect of the fluid static pressure.

6715 **(GKSS—86/E/17) Experiments on the diffusion behaviour of fission-produced cesium in $UO_2$ fuel pellets using gamma-computer tomography.** Muellauer, J. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich 13 - Chemie; GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie). 1986. 151p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750083.

The diffusion behaviour of fission-produced Cs in irradiated $UO_2$ fuel pellets with burnups between 23 and 26 GWd/t(U) was studied in the temperature range from 400 to 1600°C. The radial distribution of Cs and other γ-emitting fission products (Ru, Zr) in fuel rods was measured non-destructively by a new developed gamma-computertomography-equipment. The effective diffusion coefficient, the integral and local release of fission-generated Cs are strongly affected by deviations from the stoichiometric composition UOsub((2+x)). With 70 figs., 5 tabs.

6716 **(Juel—2045) Theoretical investigations of the fission product release out of the core of a high temperature reactor during hypothetical heat up accidents as example of caesium.** Batalas, T.A.; Iniotakis, N.; Decken, C.B. von der. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente; Technische Hochschule Aachen (Germany, F.R.)). Mar 1986. 100p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE87750077.

The investigation has been performed by means of a physical model, taking into account the micro- and macro-structures of the pyrolytical and graphitical reactor components as well as renouncing an introduction of effective diffusion coefficients by the description of the fission products transport through the coated particle layers and the fuel elements and renouncing an assumption of the spontaneously adsorption-desorption equilibrium on the surface of the fuel elements. The solving method and the respective computer codes were also developed. In addition the theoretically calculated and the experimentally determined results regarding the caesium release from single coated particles as well as fuel elements at accident temperatures were compared. Finally the caesium release from the core of the PNP-500 reactor during a heat up accident has been estimated and discussed.

6717 (NUREG/CP—0080-Vol.2, pp 639-650) **Physical chemical aspects of fission product transport in severe LWR accidents.** Ritzman, R.L.; Vogel, R.C. (Electric Power Research Institute, Palo Alto, CA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

Predictions of the radiological impact of severe accidents in light water reactors (LWRs) rely on a collection of mathematical models to estimate the conditions that would evolve and how these conditions would affect fission product redistribution over the course of such accidents. A variety of phenomenological processes and chemical interaction mechanisms must be addressed. Present capabilities to perform analysis are surveyed in the paper and several potentially important limitations in the methodology are discussed.

6718 (NUREG/CP—0080-Vol.2, pp 651-660) **Modelling of molten fuel relocation phenomena in a degraded BWR core.** SiAhmed, E.K.; Podowski, M.Z.; Lahey, R.T. Jr. (Rensselaer Polytechnic Institute, Troy, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A model of fuel melting and relocation has been developed for the analysis of core meltdown accidents of light water nuclear reactors. Both the description of the model and the results of extensive numerical testing and assessment are presented in this paper. The numerical results shown include the test runs for the standalone model, as well as the calculations performed following the implementation of this model into the MELRPI code. The latter results are compared with those obtained for the previous version of MELRPI, showing the effect of the new mechanistic model for molten fuel relocation on the accuracy of predicting the timing of core and reactor pressure vessel failure.

6719 (NUREG/CP—0080-Vol.2, pp 661-670) **Analysis of BWR-core degradation and meltdown progression using the MELRPI computer code.** Kim, S.H.; Podowski, M.Z.; Lahey, R.T. Jr.; Sozer, A. (Rensselaer Polytechnic Institute, Troy, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A computer code, MELRPI, has been developed at Rensselaer Polytechnic Institute for the analysis of Boiling Water Reactor severe accidents. This paper presents the results of the MELRPI calculations for a postulated station blackout accident in the Browns Ferry Nuclear Power Station. Also, a sensitivity study has been performed aimed at testing the various modelling assumptions used, as well as assessing the importance of the initial phase of accident scenarios on the core damage progression during later stages. In particular, the effects of uncertainties in the oxidation models and the core uncovering timing are analyzed.

6720 (NUREG/CP—0080-Vol.2, pp 671-682) **Current status of decay heat measurements, evaluations, and needs.** Dickens, J.K. (Oak Ridge National Lab., TN). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

Over a decade ago serious concern over possible consequences of a loss-of-coolant accident in a commercial light-water reactor prompted support of several experiments designed specifically to measure the latent energy of beta-ray and gamma-ray emanations from fission products for thermal reactors. This latent energy was termed decay heat. At about the same time the American Nuclear Society convened a working group to develop a standard for use in computing decay heat in real reactor environs primarily for regulatory requirements. This working group combined the new experimental results and best evaluated data into a standard which was approved by the ANS and by the ANSI. The primary work since then has been (a) on improvements to computational efforts and (b) experimental measurements for fast reactors. In addition, the need for decay-heat data has been extended well beyond the time regime of a loss-of-coolant accident; new concerns involve, for example, away-from-reactor shipments and storage. The efficacy of the ANS standard for these longer time regimes has been a subject of study with generally positive results. However, a specific problem, namely, the consequences of fission-product neutron capture, remains contentious. Satisfactory resolution of this problem merits a high priority.

6721 (NUREG/CP—0080-Vol.2, pp 683-698) **Containment failure modes: insights and uncertainties.** Haskin, F.E. (Sandia National Labs., Livermore, CA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC04-76DP00789.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The US Nuclear Regulatory Commission (NRC) recently sponsored nationwide working groups on containment loads and containment performance. These efforts, together with a reassessment of severe-accident source terms, a review by the American Physical Society of state-of-the-art methods for calculating radiological source terms, NRC technical exchange meetings with the Industry Degraded Core (IDCOR) program, and a variety of other ongoing severe light water reactor accident research programs, provide technical bases for NRC decisions regarding severe accidents. The NRC is currently integrating this array of technical information to provide rebaselined risk estimates for selected plants. As a key part of this effort, insights gained on containment loads and containment performance are being used to characterize the relative likelihoods of competing containment failure modes. Uncertainties in these relative likelihoods exist because of incomplete

knowledge regarding physical processes that affect containment loading and containment performance. This paper attempts to reflect the current state of knowledge regarding containment failure modes including uncertainties that remain. Key uncertainties are discussed and a qualitative perspective regarding their relative importance is provided.

6722 (NUREG/CP—0080-Vol.2, pp 699-719) **Role of natural circulation in severe accident analysis.** Denny, V.E. (Science Applications International Corp., Los Altos, CA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The role of natural circulation in the analysis of postulated severe accidents is reviewed. Emphasis is placed on the station blackout scenario, for which several organizations have recently contributed predictions of accident behavior. Modeling philosophies are described and key results are compared. Close agreement with respect to the effects of recirculation on the progression of the TMLB' accident appears possible. Progress on experimental validation of recirculating flow patterns and rates of flow is also reviewed. The [nonprototypic] results to date support theoretical work in progress; however, the long range of accident transients and the very large scale of commercial plants may compromise attempts to fully validate accident analysis programs.

6723 (NUREG/CP—0080-Vol.2, pp 720-729) **Experimental simulation and analytical modelling of impinging-jet-induced plate melting.** Kasprzak, S.; Podowski, M.Z.; Lahey, R.T. Jr. (Rensselaer Polytechnic Institute, Troy, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

An analysis of the ablation of a solid plate subjected to an impinging jet of molten metal has been performed, including both experiments and analytical modelling. The main purpose of this study was to investigate the possibility of using simulants to study meltdown phenomena in light water reactors. The results obtained indicates that both the interaction between the proposed simulant materials, (i.e., eutectic metal and paraffin), and that between the actual reactor materials can be described by the same analytical model.

6724 (NUREG/CP—0080-Vol.2, pp 730-741) **Degraded core modeling in MELCOR.** Summers, R.M. (Sandia National Labs., Albuquerque, NM). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2). Contract AC04-76DP00789.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A package of phenomenological models has been developed for the MELCOR code system to calculate the thermal response of structures in the core and lower plenum of an LWR during a severe accident. This package treats all important modes of heat transfer within the core, as well as oxidation, debris formation, and relocation of core and structural materials during melting, candling, and slumping. Comparison of MELCOR and MARCON calculations for the Browns Ferry BWR primary system shows many areas of agreement during the early stages of core heatup and oxidation, but very large differences at later times. Many of these differences are attributed to the effects of candling predicted by MELCOR and the lack of any mechanistic candling or debris relocation models in MARCON. The melting and slumping behavior calculated by MELCOR is in qualitative agreement with our current understanding of the processes involved.

6725 (NUREG/CP—0080-Vol.2, pp 769-779) **Safety issues related to the upgrade of the University of Missouri Research Reactor.** McKibben, J.C.; Alger, D.M.; Brugger, R.M. (Univ. of Missouri Research Reactor Facility, Columbia). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The University of Missouri Research Reactor Facility is in the process of performing safety related analyses for upgrading the reactor. The upgrades are an extended life fuel elements, a power increase, a cold neutron source, and a building addition. These upgrades will greatly enhance the capabilities of the facility. The safety analyses have provided challenging problems for staff, faculty and students. This paper discusses the parts of the upgrade and current status of the safety analyses.

6726 (NUREG/CP—0080-Vol.2, pp 929-935) **Overview of nuclear plant analyzer and data bank programs at NRC.** Odar, F.; Laats, E.T. (Nuclear Regulatory Commission, Washington, DC). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The Nuclear Plant Analyzer (NPA) is the US Nuclear Regulatory Commission's state-of-the-art safety analysis tool. This system integrates large computer simulation codes with well-developed color graphics display capabilities and numerous support packages and data bases. One of the large data base systems being developed for use with the NPA is the Nuclear Plant Data Bank (NPDB). It will be a centralized repository for power plant design and general characteristics data to be used to build the input models for the simulation codes. The NPA has been used for production operation since 1983. A variety of applications have utilized this system for nuclear power plant safety analyses and experiment evaluation. This paper describes the NPA and NPDB systems and discusses the most noteworthy of the applications of the NPA to BWR & PWR simulation efforts.

6727 (NUREG/CP—0080-Vol.2, pp 936-943) **KWU Nuclear Plant Analyzer.** Bennewitz, F.; Hummel, R.; Oelmann, K. (Kraftwerk Union Aktiengesellschaft, West Germany). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The KWU Nuclear Plant Analyzer is a real time engineering simulator based on the KWU computer programs used in plant transient analysis and licensing. The primary goal is to promote the understanding of the technical and physical processes of a nuclear power plant at an on-site training facility. Thus the KWU Nuclear Plant Analyzer is available with comparable low costs right at the time when technical questions or training needs arise. This has been achieved by (1) application of the transient code NLOOP; (2) unrestricted operator interaction including all simulator functions; (3) using the mainframe computer Control Data Cyber 176 in the KWU computing center; (4) four color graphic displays controlled by a dedicated graphic computer, no control room equipment; and (5) coupling of computers by telecommunication via telephone.

6728 (NUREG/CP—0080-Vol.2, pp 944-955) **Modeling principles and computing technology for high-speed simulation of LWR transients.** Wulff, W.; Cheng, H.S.; Mallen, A.N. (Brookhaven National Lab., Upton, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The plant analyzer recently developed at Brookhaven National Laboratory embodies the unique combination of high simulation fidelity, with convenient interactive access, much faster than real-time simulation speed and low cost. This has been achieved through a deliberate match of modeling techniques with modern, special-purpose minicomputer architecture, designed for high-speed simulations of complex systems. The BNL Plant Analyzer is a powerful engineering tool for carrying out, routinely and cost-effectively, safety analyses, optimizations of procedures, parametric studies to obtain safety margins and for generic training. It is also applicable for operator assistance through plant performance monitoring, automatic fault diagnostics and on-line support during emergencies. This paper presents five modeling principles, the criteria for selecting numerical integration techniques and the key features of the special-purpose peripheral processor, the AD10 of Applied Dynamics International.

6729 (NUREG/CP—0080-Vol.2, pp 956-966) **Analysis of the Rancho Seco overcooling event using PCTRAN - the personal computer transient analyzer.** Po, L.C.C. (Micro-Simulation Technology, Parsippany, NJ). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The once-through-steam-generator version of the Personal Computer Transient Analyzer - PCTRAN/P was used to simulate the overcooling event which occurred on December 26, 1985 at Rancho Seco. Loss of the Integrated Control System lead to a reactor trip and overfeeding by the auxiliary feedwater with excessive steam dump. As a result, the plant cooled down rapidly in a short period. PCTRAN/P has successfully reproduced the transient using its interactive control functions. Areas of the system's shortcomings are thus identified and modifications can be made to prevent a similar event from recurring. The computation time on an IBM-PC/XT was about 20 minutes for the 50 minute transient. PCTRAN is thus demonstrated to be a fast-turnaround tool for conducting reactor transient analyses.

6730 (NUREG/CP—0080-Vol.2, pp 967-978) **Analysis codes at EPRI.** Naser, J.A.; Agee, L.J. (Electric Power Research Institute, Palo Alto, CA). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The Electric Power Research Institute (EPRI) has developed a Reactor Analysis Support Package (RASP) to provide utilities with computer programs and analysis guidelines for describing nuclear power plant behavior and performance. The objective of RASP is to provide an integrated, interlinked and validated code package, which includes analysis guidelines, that can be used by utilities for both fuel reload and plant safety analysis. RASP consolidates existing core physics, thermal-hydraulics and fuel performance computer codes into an integrated and self-consistent system. The RASP methodology consists of the following integral elements: individual computer codes, linkage and traceability software, analysis guidelines and utility seminars and workshops. The RETRAN system thermal-hydraulics computer code is used in this package to perform NSSS transient analyses. RETRAN has been used extensively to analyze both operational transients and small break loss-of-coolant accidents. RETRAN is applicable to both PWR and BWR plant transient analyses. The RETRAN nuclear kinetics models, which relate thermal-hydraulic changes to core power response (point or one-dimensional kinetics), require input from the physics codes via special RASP linkage codes and therefore truly demonstrate the need for a consistent, integrated physics and thermal-hydraulics package. The purpose of this paper is to give an overview of the RASP package with special emphasis on the NSSS transient analysis code RETRAN.

6731 (NUREG/CP—0080-Vol.2, pp 979-990) **Rapid-response analysis of the Davis-Besse loss-of-feedwater event on June 9, 1985.** Lime, J.F.; Nassersharif, B.; Boyack, B.E. (Los Alamos National Lab., NM). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

At the request of the US Nuclear Regulatory Commission (NRC). The authors performed a rapid-response analysis of the loss-of-feedwater (LOFW) event that occurred at the Toledo Edison Davis-Besse plant on June 9, 1985. The initial 831 s of the plant transient were simulated and, in addition, four postulated transients were calculated to determine how the plant would have responded if feedwater had not been restored, and how it would have responded to a feed-and-bleed (FAB) decay-heat removal procedure initiated at different times. The Transient Reactor Analysis Code was used for this analysis. The authors completed these calculations within a two-week period and provided a report to the NRC 30 days later. The analysis showed that FAB was a viable decay-heat-removal procedure for the Davis-Besse plant for the initiation times analyzed. With complete LOFW and no alternate decay-heat removal procedure it was calculated that core uncovery would have occurred at about 9200 s. FAB initiated at 8 min and 13 min after complete LOFW, which in the actual LOFW transient occurred 6 min after the initiating event of a main-feedwater pump trip, was successful in that the primary system remained subcooled and water-solid throughout the transient. FAB initiated at 28 min after complete LOFW was considered successful even though it resulted in a loss of subcooling, a net loss in primary inventory, and a slow voiding of the primary system. The core would have remained covered for the nine hours that was estimated for the primary pressure to decrease to the residual-heat-removal pressure.

6732 (NUREG/CP—0080-Vol.2, pp 991-999) **Risk management microcomputer-based program.** Chizever, J.S.; Cihak, J.; Hockenbury, R.W. (Rensselaer Polytechnic Institute, Troy, NY). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

A risk management program utilizing commercial spreadsheet software for microcomputers has been developed. Information from a nuclear plant probabilistic risk assessment (PRA) is abstracted and transferred to a personal computer where it is more accessible. Fault tree, event tree, system descriptions and selected PRA resulted can be rapidly retrieved and examined. Changes due to backfits and plant modifications can be readily evaluated and their implications to total risk can be seen.

6733 (NUREG/CP—0080-Vol.2, pp 1000-1010) **French 1300 MW PRA.** Berger, J.P.; Villemeur, A. (EDF/Septien, Villeurbanne, France). Aug 1986. NTIS, PC A24/MF A01 - GPO. File Number TI86901756. (CONF-860906—Vol.2).

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The paper describes the French approach to reactor safety based on the conventional deterministic technique and the probabilistic approach as a highly useful complement. EDF has begun a probabilistic safety study on Paluel Unit 3, a standardized 1300 MW plant. The goals of the study, study characteristics, planning, and scope are described.

6734 (NUREG/CR—4564) **Operating experience and aging-seismic assessment of battery chargers and inverters.** Gunther, W.E.; Subudhi, M.; Taylor, J.H. (Brookhaven National Lab., Upton, NY (USA)). Jun 1986. Contract AC02-76CH00016. 138p. (BNL-NUREG—51971). NTIS, PC A07/MF A01 - GPO. File Number TI87000254.

This report provides an assessment of the aging of battery chargers and inverters which are vital components of the nuclear power plant electrical safety system, and was conducted under the auspices of the NRC Nuclear Aging Research (NPAR) Program. The objectives of this program are to identify concerns related to the aging and service wear of equipment operating in nuclear power plants, to assess their possible impact on plant safety, to identify effective inspection, surveillance, and monitoring methods, and to recommend suitable maintenance practices for mitigating aging-related concerns and diminish the rate of degradation due to aging and service wear. Battery charger and inverter design and materials of construction are reviewed to identify age-sensitive components. Operational and accidental stressors are determined, and their effect on promoting aging degradation are assessed. Variations in plant electrical designs, and system and plant level impacts have been studied. Failure modes, mechanisms, and causes have been reviewed from operating experiences and existing data banks. The study has also considered the seismic correlation of age-degraded components within battery chargers and inverters. The performance indicators that can be monitored to assess component deterioration due to aging or other accidental stressors are identified. Conforming with the NPAR strategy as outlined in the program plan, the study also includes a review of current standards and guides, maintenance programs, and research activities pertaining to nuclear power plant safety-related battery chargers and inverters.

6735 **(NUREG/CR—4687) Assessment of circumferentially complex-cracked pipe subjected to bending.** Kramer, G.; Papaspyropoulos, V. (Battelle Columbus Labs., OH (USA)). Oct 1986. 174p. (BMI—2142). NTIS, PC A08/MF A01 - GPO. File Number TI87900099.

In this study the validity of various analyses to predict crack initiation, maximum load, and the corresponding displacements for 6.625-inch (168-mm) diameter circumferentially complex-cracked pipe under pure bending was assessed. The results of six pipe fracture experiments on three materials (SA-376 TP304 stainless steel, Inconel 600, and A106 Grade B carbon steel) were used to verify the accuracy of these analytical predictions. Three different sets of analyses were conducted. First, the experimental pipe fracture data were compared with net-section-collapse predicted loads. These comparisons showed that some of the complex-cracked pipes failed at loads 23 to 33% below net-section-collapse predicted loads. Second, J-resistance (J-R) curves were calculated from each pipe experiment using the eta-factor method. These results revealed that the J-R curves from the complex-cracked pipe experiments were significantly less than J-R curves from 0.5T compact (tension) specimens. Furthermore, the pipe J-R curves decreased systematically with increasing ratios of surface crack depth to pipe wall thickness. Third, predictions of loads and displacements in each experiment were made using four different J-estimation schemes. Good agreement was obtained between the predictions and the experimental data up to maximum load. Once past maximum load, however, the J-estimation schemes overpredicted loads and displacements.

6736 **(NUREG/IA—0008) International agreement report: Assessment study of RELAP-5 MOD-2 Cycle 36.01 based on the DOEL-2 Steam Generator Tube Rupture incident of June 1979.** Stubbe, E.J. (Tractionel, Brussels (Belgium)). Oct 1986. 236p. NTIS, PC A11 - GPO. File Number DE87900113.

This report presents a code assessment study based on a real plant transient that occurred at the DOEL 2 power plant in Belgium on June 25th 1979. DOEL 2 is a two-loop WESTINGHOUSE PWR plant of 392 MWe. A steam generator tube rupture occurred at the end of a heat-up phase which initiated a plant transient which required substantial operator involvement and presented many plant phenomena which are of interest for code assessment. While real plant transients are of special importance for code validation because of the elimination of code scaling uncertainties, they introduce however some uncertainties related to the specifications of the exact initial and boundary conditions which must be reconstructed from available on-line plant recordings and on-line computer diagnostics. Best estimate data have been reconstructed for an assessment study by means of the code RELAP5/MOD2/CYCLE 36.01. Because of inherent uncertainties in the plant data, the assessment work is focussed on phenomena whereby the comparison between plant data and computer data is based more on trends than on absolute values. Such approach is able to uncover basic code weaknesses and strengths which can contribute to a better understanding of the code potential.

6737 **(SAND—86-0703C) Electrical penetration assemblies severe accident testing.** Keck, J.D.; Thome, F.V. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 13p. (CONF-860908—31). NTIS, PC A02/MF A01 - GPO. File Number TI87000983.

From Operability of nuclear power systems in normal and adverse environments meeting; Albuquerque, NM, USA (29 Sep 1986).

The leakage behavior of electrical penetration assemblies (EPAs) is being evaluated by varying the penetration type, manufacturer, and hypothetical temperature and pressure accident profile. Nuclear qualified EPAs were procured from D.G. O'Brien, Westinghouse, and Conax. Severe accident sequence analysis was used to generate the severe accident conditions (SAC) for a large dry PWR, a BWR Mark I drywell, and a BWR Mark III wetwell. The EPA manufacturers were matched to the reactor type based on a survey of EPAs used in reactors. The D.G. O'Brien EPA was chosen for the PWR SAC, the Westinghouse was chosen for the BWR Mark III, and the Conax was chosen for the BWR Mark I. The EPAs were radiation and thermal aged to a 40-year service life before the SAC test was conducted. For the D.G. O'Brien EPA SAC test, while there was no detectable leakage during the SAC test, there was 0.13 scc/sec leak measured during the posttest inspection. For the Westinghouse EPA and Conax EPA SAC tests, there was no detectable leakage during or after the SAC test.

6738 **(SAND—86-2266C) Performance of seals and gaskets under severe accident conditions.** Koenig, L.N. (Sandia National Labs., Albuquerque, NM (USA)). Sep 1986. Contract AC04-76DP00789. 8p. (CONF-860908—32). NTIS, PC A02/MF A01 - GPO. File Number TI87000974.

From Operability of nuclear power systems in normal and adverse environments meeting; Albuquerque, NM, USA (29 Sep 1986).

The US Nuclear Regulatory Commission (USNRC) is sponsoring a set of programs to examine the modes of failure of light-water reactor (LWR) containments subjected to severe accidents. Severe accidents, which were not considered in the design of the containments, can sometimes result in temperatures and pressures significantly above design-base conditions. Under such conditions, containment failure could occur in one or more ways: the containment building could be torn or breached; leak paths could open as a result of degraded seal and gasket materials in mechanical penetrations; sufficient deformation could occur at the sealing surfaces in mechanical penetrations to permit leakage; and leakage could occur in electrical penetrations. Programs are in place at Sandia to investigate each of these possibilities, with this paper limited to the program addressing the degradation of seal and gasket materials. As part of this program, tests are conducted on seals and gaskets to evaluate the effect of radiation aging, thermal aging, atmosphere, temperature, pressure, and seal and gasket geometries on the performance of different seal and gasket materials. The test matrix and procedures and techniques used to test these seals are discussed. Results of completed tests are reviewed. Based on the experimental data, hypotheses for leakage mechanisms in mechanical penetrations are formed.

6739 **(SSI—86-07) Fallout from Chernobyl. Preliminary report.** Kjelle, P.E. (National Inst. of Radiation Protection, Stockholm (Sweden)). May 1986. 31p. (In Swedish). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750165.

The recordings from the gamma measuring stations of the Swedish National Institute of Radiation Protection are reported. The level of gamma radiation has been measured 2.5 m above the ground level (G.B.).

6740 **(SSI—86-12) Chernobyl - its impact on Sweden.** (National Inst. of Radiation Protection, Stockholm (Sweden)). Aug 1986. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750164.

In case of radiological emergency in Sweden, the Swedish National Institute of Radiation Protection (SSI) has the responsability of organizing a special task force with experts both from SSI and from other authorities. Reports of increased radiation levels reached SSI around 10,am on April 28, 1986, and the task force convened at 1030 am. A large number of measurements were made all over the country, and temporary grazing restrictions were imposed so as to avoid excessive doses from the food chain grass-cow-milk. Attention is now concentrated on regions with high cesium activity and on foodstuffs in general. A very tentative estimate of the collective dose commiment is 10,000 man.Sv. It turned out that the general public was not always satisfied with the information provided by the authorities, in spite of complete openness.

6741 **Uncertainty in soil-structure interaction analysis of a nuclear power plant due to different analytical techniques.** Chen, J.C.; Chun, R.C.; Goudreau, G.L.; Maslenikov, O.R.; Johnson, J.J. (Lawrence Livermore National Lab., Livermore, CA). pp 905-912 of Proceedings of the eighth world conference on earthquake engineering. Volume 3. Old Tappan, NJ; Prentice Hall, Inc. (1984). (CONF-840703—).

From 8. world conference on earthquake engineering; San Francisco, CA, USA (21 Jul 1984).

This paper summarizes the results of the dynamic response analysis of the Zion reactor containment building using three different soil-structure interaction (SSI) analytical procedures: the substructure method, CLASSI; the equivalent linear finite element approach, ALUSH and the nonlinear finite element procedure, DYNA3D. Uncertainties in analyzing a soil-structure system due to SSI analysis procedures were investigated. Responses at selected locations in the structure were compared: peak accelerations and response spectra.

# 25 ENERGY STORAGE

*REFER ALSO TO CITATION(S) 7026*

6742 **Development of regenerable energy storage for space multimegawatt applications.** Olszewski, M. (Engineering Technology Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 1838-1841 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—). Contract AC05-84OR21400.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

A program has recently been initiated as a part of the national Strategic Defense Initiative (SDI) to develop energy storage technology for space power applications. This program is jointly conducted by the Department of Energy and the Department of Defense. It is focused on the development of advanced technologies in regenerable energy storage that will be required for generation of multi-megawatt levels of sprint power for SDI space missions. Energy storage technology considered in the program related to devices that have a high specific capacity for energy storage, which can provide high levels of electric power on demand, and which may be recharged with electric power. The devices of principal interest are electrochemical batteries, chemical fuel cells, and electromechanical flywheels (the latter includes the motors and generators used to provide the electrical to mechanical coupling). The intent of the program is to resolve technical feasibility issues associated with an electrically regenerable energy storage system satisfying SDI needs. Specifically, energy storage technology will be developed through the proof-of-concept stage within the next six years that provides a specific power greater than 2.5 kW/kg with an energy storage density of at least 450 kJ/kg.

## 2501 Magnetic

*REFER ALSO TO CITATION(S) 7819*

6743 **Plasma-ring, fast-opening switch.** Hartman, C.W.; Eddleman, J.; Hammer, J.H. (Lawrence Livermore National Lab., Livermore, CA). pp 23 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract W-7405-ENG-48.

The authors discuss a fast-opening switch concept based on magnetically confined plasma rings, PROS (for Plasma Ring Opening Switch). In PROS, the plasma ring, confined by $B\theta$ /sub and B/poloidal /sub fields of a compact torus, provide a low mass, localized conduction path between coaxial electrodes. To operate the switch, driver current is passed across the electrodes through the ring, storing inductive energy in external inductance and between the electrodes on the driver side of the ring. The ring is accelerated away from the driver by the field of the driver current and passes over a load gap transferring the current to the load. The authors distinguish two configurations in PROS, straight PROS where the electrodes are coaxial cylinders, and cone PROS with conical electrodes. In straight PROS ring acceleration takes place during the inductive store period as in foil switches, but with the localized ring providing the current path. Increased performance is predicted for the cone PROS (see figure) which employs compression of the ring in the cone during the inductive store period. Here, the $B/\theta$ / sub field of the driver forces the ring towards the apex of the cone but the force is in near balance with the opposing component of the radial equilibrium force of the ring along the cone. As a result, the ring undergoes a slow, quasistatic compression limited only by resistive decay of the ring field. Slow compression allows inductive storage with low-power drivers (homopoloar, magneto cumulative generators, high C-low V capacitor banks, etc.). Near the apex of the cone, near peak compression, the ring is allowed to enter a straight coaxial section where, because of low-mass, it rapidly accelerates to high velocity and crosses the load gap.

## 2505 Flywheels

6744 **Advances in flywheel technology for space power applications.** Olszewski, M.; O'Kain, D.U. (Engineering Technology Div.). pp 1823-1828 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Power derived from stored energy rather than directly from the primary thermal source is an attractive alternative for SDI sprint power. Energy storage can be achieved in a variety of ways: electric (capacitor) or magnetic (inductor) fields, inertially (flywheels), chemically (converted through fuel cells), or electrochemically (batteries). Of these several modes, flywheels are a leading contender; and Energy Systems has initiated a major effort to advance energy storage flywheel performance. The Enrichment Technology Applications Center (ETAC) was created to utilize unique enrichment program-based expertise and facilities for applications in other government programs and emerging technologies of national interest. Research and development activities are focused on high-performance flywheel energy storage systems, and early testing has demonstrated high speed capability using carbon composite flywheel rims. A burst speed of 1405 m/s was achieved with a 7.28 MJ flywheel demonstration unit. The specific energy of the rim in this demonstration unit was 878 kJ/kg (244 Wh/kg). Prior to this, flywheel rims had attained burst speeds of 1000 m/s with specific energy levels on the order of 105 Wh/kg. The Flywheel Energy Storage Program is aimed at developing a high-performance flywheel energy storage module with a total stored energy of one gigajoule; anticipated operating speed is in the range of 1100-1200 m/s.

## 2506 Thermal

6745 **Aquifer thermal energy storage in the United States.** Kannberg, L.D. (Underground Energy Storage Program, Pacific Northwest Lab., Richland, WA). pp 3-8 of Enerstock 85. Hull, Quebec; Canadian Government Pub. Centre Supply and Services (1985). (CONF-850905—). Contract AC06-76RL01830.

From ENERSTOCK '85 - international conference on energy storage for building heating and cooling; Toronto, Canada (22 Sep 1985).

The United States Department of Energy (DOE) has funded investigation of Aquifer Thermal Energy Storage (ATES) since 1975. The scope of the ATES investigation has encompassed numerical modeling, field testing, economic analyses, and evaluation of institutional issues. ATES has received the bulk of the attention because of its widespread potential in the U.S. U.S. efforts are now concentrated on a high temperature (up to 150°C) ATES field test on the St. Paul campus of the University of Minnesota. Four short-term test cycles and the first of two long-term test cycles habe been completed at this site. Utilization of chill ATES to meet summer air conditioning demands has been monitored at two operating sites in Tuscaloosa, Alabama. The systems utilize a cooling tower to directly chill groundwater pumped from a water table aquifer for storage in the same aquifer.

6746 **Impact of water quality on aquifer thermal energy storage.** Allen, R.D. (Pacific Northwest Lab., Richland, WA 99352). pp 20-24 of Enerstock 85. Hull, Quebec; Canadian Government Pub. Centre Supply and Services (1985). (CONF-850905—). Contract AC06-76RL01830.

From ENERSTOCK '85 - international conference on energy storage for building heating and cooling; Toronto, Canada (22 Sep 1985).

Ground-water quality may affect the regional potential for aquifer thermal energy storage (ATES). Six mechanisms can impair reservoir permeability: 1) particulate plugging, 2) chemical precipitation, 3) liquid-solid reactions, 4) formation disaggregation, 5) oxidation reactions, and 6) biological activity. Countermeasures to reduce these effects are identified. The chemistry of ground-water depends upon solution, precipitation, and fluid mixing. Modeling of water analyses indicated three problem reactions: 1) precipitation of calcium carbonate at elevated temperature; 2) solution of silica at elevated temperature, followed by its precipitation at lowered temperature; and 3) oxidation and precipitation of iron compounds. Aquifers composed of quartz sands and sandstones are promising for low temperature and chilled water storage. Quart-bearing rocks are promising for high temperature storage, if silica dissolution and precipitation is insignificant.

6747 **Investigation of the vertical-flow aquifer thermal energy storage concept and numerical simulation of the Dorigny field experiment.** Doughty, C.; Tsang, C. (Earth Sciences Div., Lawrence Berkeley Lab., Berkeley, CA). pp 58-64 of Enerstock 85. Hull, Quebec; Canadian Government Pub. Centre Supply and Services (1985). (CONF-850905—). Contract AC03-76SF00098.

From ENERSTOCK '85 - international conference on energy storage for building heating and cooling; Toronto, Canada (22 Sep 1985).

A mathematical modeling study of the vertical-flow aquifer thermal energy storage concept is made. A history match calculation of the Dorigny field experiment, part of the SPEOS project, is carried out using two simplified models. Then the main heat-loss mechanisms are isolated to study their relative importance. Finally, variations on the Dorigny experimental configuration are studied to examine the behavior of the vertical-flow storage system in general.

6748 **A computer code for analyzing the performance of Aquifer Thermal Energy Storage systems.** Vail, L.W.; Kannberg, L.D.; Kincaid, C.T. (Pacific Northwest Lab., Richland, WA). pp 144-148 of Enerstock 85. Hull, Quebec; Canadian Government Pub. Centre Supply and Services (1985). (CONF-850905—). Contract AC06-76RL01830.

From ENERSTOCK '85 - international conference on energy storage for building heating and cooling; Toronto, Canada (22 Sep 1985).

Investigating the performance of Aquifer Thermal Energy Storage (ATES) systems is the principal activity of the Underground Energy Storage Program. To aid the analysis of ATES systems, a suite of computer codes, ranging from complex three-dimensional geohydrological models to economic models of ATES systems have been developed. Recently, a code called Aquifer Thermal Energy Storage System Simulator (ATESSS) has been developed to analyze the operational performance of ATES systems.

6749 **New phase-change thermal energy storage materials for buildings.** Benson, D.K.; Christensen, C.B.; Burrows, R.W.; Shinton, Y.D. (Solar Energy Research Institute, Golden, CO). pp 416-420 of Enerstock 85. Hull, Quebec; Canadian Government Pub. Centre Supply and Services (1985). (CONF-850905—).

From ENERSTOCK '85 - international conference on energy storage for building heating and cooling; Toronto, Canada (22 Sep 1985).

A new class of phase-change thermal energy storage materials is under development at SERI. These materials are presented here.

## 2509 Batteries

6750 **(AD-A—171703/2/XAB) Ion conducting polymers as solid electrolytes. Final report, 1985-1986.** Semancik, J.D. (Naval Academy, Annapolis, MD). 28 May 1986. 71p. (USNA-TSPR—139). NTIS, PC A04/MF A01.

Electrically conducting polymers have recently been the subject of much interest. In particular, their potential as electrolytes in solid-state batteries has gained the attention of the U.S. Navy. Current ion-conducting polymers have conductivities too low by a factor of ten at operational temperatures. In order to be able to obtain suitable conductivities in these polymers, a thorough understanding of the mechanisms governing ion motion in them must be attained. The processes involved in the ion conduction of one particular polymer, poly(propylene oxide) or PPO, were studied in this research. Samples were prepared using an ion-implantation procedure developed as part of the project as well as by the traditional chemical complexing technique involving alkali-metal salt doping. The samples produced were analyzed using both differential scanning calorimetry and audio-frequency complex impedance measurements. Results indicate that the polarity of the salts has a major effect upon the activation volume and the glass transition of PPO. As a result of these effects, it seems that nonpolar anions may aid in increasing the cationic transport number of the polymer. More importantly, the first direct numerical evidence of a connection between the large-scale segmental motions of the polymer chains and the chains and the conductivity has been established.

6751 **(CONF-860810—38) Stable, high performance lithium/iron disulfide cell with LiCl-LiBr-KBr molten electrolyte.** Kaun, T.D. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001475.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

A stable Li-Al/$FeS_2$ cell with a greater than 50% increase in specific energy and specific power has been developed. This cell has two major changes from earlier cells of this type: (1) a novel electrolyte, 25 mol % LiCl-37 mol % LiBr-38 mol % KBr (m.p. 310°C) rather than 58 mol % LiCl-42 mol % KCl (m.p. 352°C), and (2) a higher loading density (2.4 vs. 1.5 Ah/cm³) for the $FeS_2$ electrode, which is then operated only on its higher voltage plateau (1.75 V vs. Li-Al). This cell design is designated "dense upper-plateau (U.P.) $FeS_2$ cell" to distinguish it from the conventional "two-plateau (T.P.) $FeS_2$ cell." The new electrolyte permits reduced operating temperatures of 380 to 420°C. Conventional cells are operated in a temperature range of 425 to 460°C. The use of the dense U.P.-$FeS_2$ electrode and the lower melting LiCl-LiBr-KBr electrolyte has eliminated the capacity-loss problem of the Li-Al/$FeS_2$ system. A dense U.P.-$FeS_2$ electrode cell had no change in capacity utilization (about 89%) after 400 cycles (5400 h) of operation. With LiCl-KCl electrolyte, a $FeS_2$ cell would have lost 30% of its capacity in the first 200 cycles. Based on the improved performance, advanced cell designs are expected to achieve a specific energy of 175 Wh/kg at 4-h rate and a specific power of 200 W/kg at 80% depth of discharge.

6752 **(SAND—86-1082C) Preliminary determination of electrolyte stress during freeze/thaw cycling of a Na/S cell.** Braithwaite, J.W.; Subia, S.R.; Hammetter, W.F. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 22p. (CONF-861068—12). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002050.

From Electrochemical Society fall meeting; San Diego, CA, USA (19 Oct 1986).

Sandia National Laboratories is developing a capability to predict the mechanical-stress profile in a Na/S cell's $\beta''$-alumina electrolyte during freeze/thaw cycling. This activity, if successful, will assist battery designers in their efforts to increase battery lifetime. This paper contains a brief summary of the important aspects that have been completed for the three major components of this activity: (1) development of a thermo-mechanical, computer-based calculational methodology with emphasis given to the results from a simulation of a simple freeze/thaw failure, (2) measurement of the physical properties of the positive electrode materials, and (3) direct measurement of the stress generated within a laboratory Na/S cell.

6753 **Overview of rechargeable battery testing in the United States.** Butler, P.C. (Sandia National Labs., Albuquerque, NM, USA). *Journal of Power Sources;* **17**: No. 1-3, 64-71(Jan-Apr 1986). (CONF-8509154—). Contract AC04-76DP00789.

From International battery testing workshop; Heidelberg, F.R. Germany (29 Sep 1985).

Battery testing activities are a significant part of many battery development and engineering programs in the United States. Improved and advanced cells and batteries are being evaluated for electric vehicle, load-leveling, solar, aerospace, and military applications. These programs are being carried out by industrial, national, military, and other independent laboratories. Many testing laboratories are funded by the U.S. Department of Energy (DOE) for the evaluation of systems being developed by independent and government-funded programs. This paper will describe, in general terms, battery testing facilities, types of electrochemical systems on test, and testing methods for both DOE-funded and some independently-funded programs.

6754 **Rationale and methodology for group testing of electric vehicle batteries.** Hardin, J.E.; Hunt, G.L.; Dowgiallo, E.J. Jr.; Burke, A.F. (Idaho National Engineering Lab., Idaho Falls, USA; Department of Energy, Washington, DC, USA. Div. of Electric and Hybrid Vehicle Systems; Union Coll., Schenectady, NY, USA). *Journal of Power Sources;* 17: No. 1-3, 97-106(Jan-Apr 1986). (CONF-8509154—).

From International battery testing workshop; Heidelberg, F.R. Germany (29 Sep 1985).

Testing batteries in both the laboratory and in vehicles is an important part of evaluating new batteries and electric drivelines for electric vehicles. In the development of a new battery design, tests are made of cells, modules, and packs. The initial tests are made using cells and later, modules consisting of a number of cells are tested. Finally, a number of modules in a pack are tested in a vehicle. In all cases the tests should be made in such a way that the results are meaningful for realistically assessing the use of the new battery in an electric vehicle application (i.e., particular vehicle design and use-pattern).

6755 **Flowing electrolyte batteries. Test methods and results.** Butler, P.C.; Robinson, C.E. (Sandia National Labs., Albuquerque, NM, USA). *Journal of Power Sources;* 17: No. 1-3, 127-134(Jan-Apr 1986). (CONF-8509154—). Contract AC04-76DP00789.

From International battery testing workshop; Heidelberg, F.R. Germany (29 Sep 1985).

Prototype zinc/bromine, zinc/ferricyanide, and iron/chromium redox flowing electrolyte cells and batteries have been tested at Sandia National Laboratories since 1980 in order to evaluate development program progress. These units have been subjected to baseline tests to determine stable operating conditions, a factorial test matrix to evaluate the sensitivity of electrochemical efficiency to changes in operating conditions, and life cycle tests. In some cases, stable baseline performance was not obtained and, therefore, the other test modes were not performed. Also, some batteries failed prior to completion of the factorial test matrix. In three cases, however, the entire test regime was implemented and completed; these batteries are still on life cycle test. This paper will review the test methods used to evaluate these batteries. The factorial test matrix and its results will be described. Other necessary aspects of prototype testing, such as operation and maintenance issues, will be discussed.

6756 **Examination of battery-related electric vehicle track and field measurements.** Dowgiallo, E.J. Jr.; Kevala, R.J. (Department of Energy, Washington, DC, USA. Div. of Electric and Hybrid Vehicle Systems; Aerospace Corp., Washington, DC, USA). *Journal of Power Sources;* 17: No. 1-3, 248-256(Jan-Apr 1986). (CONF-8509154—).

From International battery testing workshop; Heidelberg, F.R. Germany (29 Sep 1985).

The US Department of Energy Electric and Hybrid Vehicle Program activities include on-the-road evaluation of electric vehicles (EVs) by site operators at several locations throughout the US. Daily vehicle operation and maintenance logs and energy input data are recorded by these site operators, which provide useful operating information about the EV fleet of more than 500 vehicles. However, in evaluating improved products and components or in assessing the capabilities of vehicles equipped with different batteries, more detailed engineering data are required. To acquire the needed data and to better understand the differences in performance observed under field and laboratory conditions, an onboard instrumentation system is essential. Such a system is discussed.

6757 **(N—86-29412) Current developments in electrochemical storage systems for satellites.** Gutmann, G. Translated from *Zeitschrift fuer Flugwissenschaften und Weltraumforschung ;* No. 9, 229-235(Jul-Aug 1985). 22p. (NASA-TM—88471; NAS—1.15:88471). NTIS, PC A02/MF A01.

The need for batteries with greater power capacity and service life for power satellites is examined. The Ni/Cd and Ni/H batteries now being used must be upgraded to meet advanced space requirements. Improvements in power capacity, service life, and cycle count for various satellites in LEO and GEO orbits are discussed. The Ni/Cd and Ni/H cell reactions are explained, and the solubility and volume changes for various charged and uncharged masses are described. A chart of the energy content and cycle count for various cell systems is presented, and the factors which cause aging and failure in the Ni/Cd and Ni/H cell systems are discussed. The advantages of the Ni/H battery are given and the need for more developed electrochemical storage systems because of an increase in the mass of satellites is explained. The requirements for space batteries and the work currently done by NASA and West Germany on advanced batteries are discussed.

# 29 ENERGY PLANNING AND POLICY

## 2901 Energy Analysis And Modeling

*REFER ALSO TO CITATION(S) 6790*

6758 **(NP—7770032) Economic and technological optimization of the energy supply system of the Federal Republic of Germany using a linear multi-criterion optimization model.** Hanicke, T. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Wirtschaftswissenschaften). 12 Feb 1985. 422p. (In German). NTIS (US Sales Only), PC A18/MF A01. File Number DE87770032.

This publication deals with the analysis of the energy supply system of the Federal Republic of Germany. Emphasis is on the effects of alternative policies on the system's optimal structure. Being the most suitable and for mathematical and formal purposes the most fruitful one, the study chooses a linear optimization model. The model has been derived from the MESSAGE energy model developed by the International Institute for Applied Systems Analysis in Laxenburg. A survey of the present economic, technological and environmental situation of Western German energy economy is followed by a survey of different methodological models and a number of existing energy models. Finally, the publication gives a description of the MESSAGE model placing particular emphasis on its variables and individual restrictions. In order to describe different states of environmental impacts in correlation with alternative emission standards, most of the conventional technologies do undergo multiple realization. These so-called technology variants are evaluated on the basis of the respective emission standards. The respective criteria decide on the variants to be actually applied in energy production processes. They also decide on their capacitive share in the process.

## 2902 Economics And Sociology

*REFER ALSO TO CITATION(S) 6471, 6476, 6477, 6478, 6479, 6506, 6567, 6575, 6678, 6770*

## 2903 Environment, Health, And Safety

*REFER ALSO TO CITATION(S) 6575, 7414, 7482*

6759 **(PB—86-242625/XAB) Program of the National Institute for Occupational Safety and Health: FY 1986 program plan.** (National Inst. for Occupational Safety and Health, Rockville, MD (USA)). Feb 1986. 202p. (DHHS/PUB/NIOSH—86/109). NTIS, PC A10/MF A01.

Contents include: occupational lung diseases, musculoskeletal injuries, occupational cancers, severe occupational traumatic injuries, cardiosvascular diseases, disorders of reproduction, neurotoxic disorders, noise-induced loss of hearing, dermatologic conditions, psychologic disorders, assistance requests, administration.

6760 **(PB—86-242740/XAB) Development of new bioassay protocols.** Duke, K.M.; Merrill, R.G. (Battelle Columbus Labs., OH (USA)). 1981. 23p. NTIS, PC A02/MF A01.

Published in Management of Toxic Substances in Our Ecosystems--Taming the Medusa, Chapter 6, 101-120, 1981.

The chapter explains the philosophy and usefulness of a phased approach in assessing potential environmental hazards of stationary source emissions, and gives examples of the experience and success of the approach to date. Recognition of the problems associated with the environmental release of wastes has resulted in environmental legislation, including the Clean Air and Clean Water Acts and their various amendments, and the Resource Conservation and Recovery Act (RCRA). The U.S. EPA has developed an environmental-assessment program for obtaining such information for waste streams. The wastes from industrial and energy-conversion processes constitute a major source of exposure for humans and other organisms. Large quantities of such wastes are released annually to the environment in gaseous, liquid, and solid forms. Exposure by organisms is by direct inhalation, ingestion, or absorption through food-web transfer.

6761 **(PB—86-244191/XAB) Public health and environmental-exposure assessment: UNISON PCB Separation Facility, Henderson County, Kentucky (draft).** (Environmental Protection Agency, Atlanta, GA (USA). Region IV). Aug 1986. 288p. (EPA—904/9-86/141). NTIS, PC A13/MF A01.

The report summarizes the results of a Public Health and Environmental Exposure Assessment conducted by EPA Region IV on the proposed UNISON* PCB separation facility to be operated in Henderson County, Kentucky. The report is intended primarily as a public information document which describes those aspects of EPA's study which can be revealed without compromising UNISON trade secrets. The report summarizes information and analyses required by EPA to evaluate a request by UNISON to operate an alternate method of PCB disposal under the Toxic Substances Control Act (TSCA).

6762 **(PB—86-247319/XAB) Environmental quality 1984. The fifteenth annual report of the Council on Environmental quality together with the president's message to Congress.** (Council on Environmental Quality, Washington, DC (USA)). 1984. 736p. NTIS, PC A99/MF A01.

The report is the 15th Annual Report of the Council on Environmental Quality (CEQ) and marks another milestone in the development of a unified national environmental policy. That development has not been easy. For the past 15 years, numerous statutes dealing with environmental quality and natural resources have been enacted, with each new law designed to solve some specific pollution or resource problem, rather than to advance environmental quality as a whole. Thus, they provided little flexibility for resolving difficulties arising when the solution to one problem caused or exacerbated another. The tasks of blending these diverse laws into a more unified environmental policy, and of structuring the responsibilities of the environmental agencies accordingly, is a difficult one. The report may be viewed as a progress report in that effort.

6763 **(PB—86-247343/XAB) Innovative- and alternative-technology projects: 1986 progress report.** (Environmental Protection Agency, Washington, DC (USA). Office of Municipal Pollution Control). Sep 1986. 57p. NTIS, PC A04/MF A01.

Contents include: (1) innovative-technology project descriptions (overland flow, sequencing batch reactors, intrachannel clarification, hydrograph-controlled-release lagoons, vacuum-assisted sludge-dewatering beds, ultraviolet disinfection, countercurrent aeration systems), and (2) alternative-technology case studies (Cedar Rocks, West Virginia, vacuum-collection system; Cannon Beach, Oregon, wetlands/marsh system; Clayton County, Georgia, spray irrigation and wastewater recycling system; Kenbridge, Virginia, overland flow system; East Richland County, South Carolina, sludge composting system; and Charlotte, Michigan, methane-recovery system).

## 2904 Natural Resources

*REFER ALSO TO CITATION(S) 6762*

6764 **(PB—86-244514/XAB) Demand for water-resources information: a conceptual framework and empirical investigation. Final report.** Shabman, L.A.; Osborn, C.T. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Jun 1986. 376p. NTIS, PC A17/MF A01.

The continued effectiveness of the Federal water-data-collection effort is an area of special concern to many, because more than 30 Federal agencies collect some form of data. With less funding available, agencies are exploring methods to increase the efficiency of their data-collection programs and the value of the information produced. A framework based on a literature review of organizational decision processes has been developed to consider the nature of the demand and the value for decision makers in public water-management organizations. The paper reports the results of an empirical model that relates decision maker's use of the Water Resource Council's Second National Water Assessment and hypothetical expenditures on national assessment information to agency characteristics in two water basin management situations: instream versus offstream water-use competition in the Missouri River basin, and low freshwater inflows to Chesapeake Bay.

## 2905 Research, Development, Demonstration, And Commercialization

*REFER ALSO TO CITATION(S) 6401, 6410, 6411, 6412, 6413, 6428, 7498*

6765 **(TVA/ONRED/EQS—86/2a) Environmental research. Volume 1. Summary.** Brown, L.R. (ed.). (Tennessee Valley Authority, Knoxville (USA). Environmental Quality Staff). Aug 1986. 44p. NTIS, PC A03/MF A01. File Number DE87900078.

TVA's environmental research activities are focused on five key environmental issues: acid deposition, air quality (including indoor air quality), waste management, groundwater quality, and surface water quality. This year another section, Forest and Wildlife Management, has been added to describe TVA's activities in natural resource management. TVA's current natural resource management efforts are summarized in the last section of the report. This report describes research activities and presents significant results to encourage sharing of resources and information.

6766 **(TVA/ONRED/EQS—86/2b) Environmental research. Volume 2. Projects.** (Tennessee Valley Authority, Knoxville (USA). Environmental Quality Staff). Aug 1986. 142p. NTIS, PC A07/MF A01. File Number DE87900079.

TVA's environmental research activities are focused on five key environmental issues: acid deposition, air quality (including indoor air quality), waste management, groundwater quality, and surface water quality. This year another section, Forest and Wildlife Management, has been added to describe TVA's activities in natural resource management. This report contains project summaries for each research activity described.

## 2906 Nuclear Energy

*REFER ALSO TO CITATION(S) 6566, 6567, 6575, 6678, 7269, 7482, 7497*

**6767 (SSI—86-14) What does Chernobyl teach us.** Bengtsson, G. (National Inst. of Radiation Protection, Stockholm (Sweden)). Aug 1986. 6p. (In Swedish). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750168.

The accident has caused great problems and rendered large collective doses to the population. Difficulties concerning spread of information are discussed. Evaluation of risk seems to differ considerably from authorities to individuals (G.B.).

## 2910 Conservation

*REFER ALSO TO CITATION(S) 6790, 6792, 6793*

**6768 (CONF-8508111—Vol.2, pp 64-66) Evaluation role for Hawaii's energy conservation program improvements.** Moreau, J.W. 1985. NTIS, PC A15/MF A01. File Number DE86011426.

From 2. national conference on energy program evaluation; Chicago, IL, USA (19 Aug 1985).

This paper describes plans of the State of Hawaii Department of Planning and Economic Development (DPED) to use evaluation as a management tool to improve the effectiveness of its energy conservation programs. Information obtained at a workshop conducted in San Francisco by the US Department of Energy in April 1984, was used to initiate a two-step evaluation effort. In step one, two resource team members for the April workshop were retained by DPED as consultants to conduct a follow-up workshop and assist in the preparation of RFP's and review contract documents. Evaluation designs were produced for the EES, SECP and ICP components of the program and an overall management design. These draft designs were presented to DPED staff and consultants at the follow-on workshop in Honolulu. Final designs were submitted in June and have been reviewed by the consultants and the DPED staff. Step two will be the implementation of the evaluation program over the next two years, using a combination of staff and personal services contracts.

**6769 (EPRI-EM—4790-CCM-Vol.1) Manuals for the energy conservation and management computer model. Volume 1. Description manual.** McChesney, H.R. (United Technologies Research Center, East Hartford, CT (USA). Advanced Systems Technology). Oct 1986. 226p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920083.

With the energy conservation and management model, utility customer service departments can assist industrial customers in critically evaluating plant performance. Now in use at eight utilities, the model can be a valuable tool in improving the efficiency of existing equipment systems and in assessing the cost savings possible with newer, more-energy-efficient technologies. This report, Volume 1, describes the computer program methodology and the engineering database. The computer model was structured to permit a high level of flexibility in analyzing a wide variety of waste heat recovery/thermal energy storage concepts for proposed industrial EC and M application. An economic analysis used in the model calculates discounted cash-flow functions and payback periods of each potential EC and M system as part of the normal evaluation procedure to ensure that the design of the system has a sound cost bases.

**6770 (PB—86-247640/XAB) Utility competition with small business. Final report.** D'Addario, P.J. (Stronberg and D'Addario Ltd., Washington, DC (USA)). 10 Jun 1986. 89p. NTIS, PC A05/MF A01.

The purpose of the study is to take a further, and broader, look at the competition issue between utilities and small businesses of energy-related utility programs. The contractor examined in greater depth the reasons for utility interest in diversifying into nonregulated, and competitive, energy-related fields; the elements of utility subsidization of these non-regulated activities; the potential remedies that small businesses have to counter unfair or illegal competition; the scope of the cross-subsidy problem; and the effectiveness of specific actions taken by small businesses against utilities. The purpose of the report is, therefore, to address these five areas, including five key case studies of actual small business complaints against alleged unfair or illegal utility competition.

## 2920 Supply, Demand, And Forecasting

*REFER ALSO TO CITATION(S) 6506*

## 2930 Policy, Legislation, And Regulation

*REFER ALSO TO CITATION(S) 6566, 6567, 6678, 6768, 7414*

## 2940 Fossil Fuels

*REFER ALSO TO CITATION(S) 6401, 6410, 6411, 6412, 6413, 6428, 6471, 6476, 6477, 6478, 6479, 6486, 6486, 6487*

## 2950 Hydrogen And Synthetic Fuels

*REFER ALSO TO CITATION(S) 6587*

## 2960 Electric Power

*REFER ALSO TO CITATION(S) 6506*

**6771 (AD-A—172019/2/XAB) Life-Cycle-Cost Model for mobile electric power. Final report, 29 January-31 August 1986.** Young; Ford; Steinbock. (Science Applications International Corp., McLean, VA (USA)). 29 Aug 1986. 108p. NTIS, PC A06/MF A01.

This report contains the Users Guide to the Life Cycle Cost Model developed for mobile electric power. The model was developed using SYMPHONY software and follows the Army 5 Phase Cost Methodology. Appendix A contains the Variable Input Sheets fo each cost Element in the model, and Appendix B describes the menu tree structure of the model. The model is based upon the most widely used approach to costing the specific type of systems developed at Belvoir Research Development and Engineering Center.

**6772 (AD-A—172020/0/XAB) Life-Cycle-Cost Model for mobile electric power. Appendix A. Final report, 29 January-31 August 1986.** Young; Ford; Steinbock. (Science Applications International Corp., McLean, VA (USA)). 29 Aug 1986. 78p. NTIS, PC A05/MF A01.

Appendix A contains blank Variable Input Sheets for three subsystems.

**6773 (DOE/EIA—0226(86/08)) Electric power monthly, August 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 12 Nov 1986. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002527.

Net generation from nuclear-powered units reached a record high in August 1986, 37,483 gigawatthours. The previous 1-month nuclear-powered net generation record occurred in January 1986 when electric utilities generated 36,219 gigawatthours of electricity. In August 1986, nuclear-powered net generation was 7.7% higher than in August 1985 and represented 16.6% of all electricity produced during the month. In August 1986, petroleum represented 6.9% of the total electricity produced during the month.

**6774 (DOE/EIA—0397(86/2Q)) Electric Power Quarterly, April-June 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 28 Oct 1986. 327p. NTIS, PC A15/MF A01 - GPO; 1; GPO Dep. File Number DE87002260.

In this report, data collected on Form EIA-759 regarding electric utilities' net generation, fuel consumption, and fuel stocks are presented on a plant-by-plant basis. In addition, quantity, cost, and quality of fossil fuel receipts collected on the Federal Energy Regulatory Commission (FERC) Form 423 are presented on a plant-by-plant basis. The report also presents a quarterly summary of disturbances and unusual occurrences affecting the electric power industry collected by the Office of International Affairs and Energy Emergencies (IE) on the Form IE-417.

6775 **(PB—86-246154/XAB) Final report: technical contributions to the development of incipient fault detection/location instrumentation.** Anderson, W.E.; Ramboz, J.D.; Ondrejka, A.R. (National Bureau of Standards, Washington, DC (USA). Electrosystems Div.). Apr 1986. 84p. (NBSIR—86/3392). NTIS, PC A05/MF A01.

The transmission of electrical energy by use of underground cables is increasing. Fault location techniques have certain limitations; incipient fault detection and location would help reduce the maintenance cost of these lines as well as improve the reliability of service. The report discusses some test results related to RF-probing techniques applied to high-voltage transmission lines. The high-frequency losses and attenuation in high-voltage cables places certain ultimate limitations on RF-probing techniques for incipient fault detection. Time-domain reflectrometry methods were employed to assess the RF-transmission properties of high-voltage cables at frequencies as high as 6 GHz. Fast-Fourier-transform deconvolution was used to obtain loss measurements as a function of frequency. The loss mechanisms were identified. The measurement hardware and methods are discussed as well as analysis approach leading to the conclusions.

6776 **Artificial intelligence solutions to power system operating problems.** Schulte, R.P.; Sheble, G.B.; Larsen, S.L.; Wrubel, J.W. Piscataway, NJ; IEEE Service Center (1986). 7p. (CONF-860705—). IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854.

From IEEE Power Engineering Society summer meeting; Mexico City, Mexico (20 Jul 1986).

This paper is one of a series for use in Current Operational Problems (COPS) Forums with the goal of focusing attention on problems faced by electric utility operators. These short notes are intended to describe the problems and the complexity of solution to the problems. The short note papers presented here describe the spectrum of power system operating problems that are believed to be good candidates for Artificial Intelligence (AI) solution. The first short note lists many of these applications and discusses their characteristics and why they are candidates for AI. The second describes an existing application that uses a knowledge base derived from operator experience. The third describes a research project now being conducted toward solving the alarm processing problem and the last short note introduces some of the problems to be encountered in implementing AI in an energy management system.

### 2990 Unconventional Sources And Power Generation

*REFER ALSO TO CITATION(S) 6600, 6609*

## 30 DIRECT ENERGY CONVERSION

### 3001 Mhd Generators

6777 **(DOE/ID/01745—T11) Mountain States Energy quarterly technical progress report, July 1-September 30, 1986.** (Mountain States Energy, Inc., Butte, MT (USA)). 1986. Contract AC07-78ID01745. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002302.

The Component Development and Integration Facility (CDIF) is a major US Department of Energy magnetohydrodynamic (MHD) test facility in Butte, Montana. The CDIF is operated by Mountain States Energy, a division of MSE, Inc. Within the national MHD program, the CDIF is responsible for performing integration testing of vendor-supplied MHD power train components to support the goal of commercialization. During the fourth quarter of FY86, results of the baseline conductivity/power test series were confirmed, and the MHD seed characterization test series continued. Record durations at the CDIF were set for coal burn time and power generation in the Faraday and diagonal operating modes.

### 3003 Thermoelectric Generators

6778 **The General-Purpose Heat Source Radioisotope Thermoelectric Generator: Power for the Galileo and Ulysses missions.** Bennett, G.L.; Lombardo, J.J.; Hemler, R.J.; Peterson, J.R. (Div. of Special Applications, U.S. Dept. of Energy, Washington, DC 20545). pp 1999-2011 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Electrical power for NASA's Galileo mission to Jupiter and ESA's Ulysses mission to explore the polar regions of the Sun will be provided by General-Purpose Heat Source Radioisotope Thermo-electric Generators (GPHS-RTGs). Building upon the successful RTG technology used in the Voyager program, each GPHS-RTG will provide at least 285 W(e) at beginning-of-mission. The design concept has been proven through extensive tests of an electrically heated Engineering Unit and a nuclear-heated Qualification Unit. Four flight generators have been successfully assembled and tested for use on the Galileo and Ulysses spacecraft. All indications are that the GPHS-RTGs will meet or exceed the power requirement of the missions.

### 3005 Fuel Cells

*REFER ALSO TO CITATION(S) 6802*

6779 (DOE/METC—86/6042, pp 176-189) **Study of the effects of soot, particulates and other contaminants on molten carbonate fuel cells fueled by coal.** Klinger, J.; Kennedy, H. (Energy Research Corp., Danbury, CT). Jul 1986. NTIS, PC A17/MF A01. File Number DE86001088. (CONF-860648—).

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The objective of the present 29-month study is to investigate the effects of contaminants in coal-derived fuel gases on overall performance and endurance of the Molten Carbonate Fuel Cell (MCFC). Specific goals are to evaluate soot deposition due to unstable fuel gas composition at typical MCFC temperature, or tar formation due to small amounts of heavy hydrocarbons in coal gas. Further goals are to evaluate, set limits, and suggest cleanup methods with respect to other contaminants in the gas stream such as particulates, arsenic, ammonia and trace amounts of volatile metal compounds including possibly zinc vapor derived from a FeO/ZnO pretreatment, desulfurization step. Soot formation effects of particulates, arsenic, trace metals, hydrocarbon contaminants, and zinc vapor, and particulate modelling are discussed.

6780 **(N—86-29409) Theoretical and experimental flow cell studies of a hydrogen-bromine fuel cell, part 1. M.S. Thesis. Final report.** Savinell, R.F.; Fritts, S.D. (Akron Univ., OH (USA)). Mar 1986. 214p. (NASA-CR—177165; NAS—1.26:177165). NTIS, PC A10/MF A01.

There is increasing interest in hydrogen-bromine fuel cells as both primary and regenerative energy storage systems. One promising design for a hydrogen-bromine fuel cell is a negative half cell having only a gas phase, which is separated by a cationic exchange membrane from a positive half cell having an aqueous electrolyte. The hydrogen gas and the aqueous bromide solution are stored external to the cell. In order to calculate the energy storage capacity and to predict and assess the performance of a single cell, the open circuit potential (OCV) must be estimated for different states of change, under various conditions. Theoretical expressions were derived to estimate the OCV of a hydrogen-bromine fuel cell. In these expressions temperature, hydrogen pressure, and bromine and hydrobromic acid concentrations were taken into consideration.

Also included are the effects of the Nafion membrance separator and the various bromide complex species. Activity coefficients were taken into account in one of the expressions. The sensitivity of these parameters on the calculated OCV was studied.

6781 (N—86-31409, pp vp) **Thermally regenerative hydrogen/oxygen fuel cell power cycles.** Morehouse, J.H. Jul 1986. NTIS, PC A99/MF E03. (NASA-CR—171931; NAS—1.26:171931).

In NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1985.

Two innovative thermodynamic power cycles are analytically examined for future engineering feasibility. The power cycles use a hydrogen-oxygen fuel cell for electrical energy production and use the thermal dissociation of water for regeneration of the hydrogen and oxygen. The TDS (thermal dissociation system) uses a thermal energy input at over 2000 K to thermally dissociate the water. The other cycle, the HTE (high temperature electrolyzer) system, dissociates the water using an electrolyzer operating at high temperature (1300 K) which receives its electrical energy from the fuel cell. The primary advantages of these cycles is that they are basically a no moving parts system, thus having the potential for long life and high reliability, and they have the potential for high thermal efficiency. Both cycles are shown to be classical heat engines with ideal efficiency close to Carnot cycle efficiency. The feasibility of constructing actual cycles is investigated by examining process irreversibilities and device efficiencies for the two types of cycles. The results show that while the processes and devices of the 2000 K TDS exceed current technology limits, the high temperature electrolyzer system appears to be a state-of-the-art technology development. The requirements for very high electrolyzer and fuel cell efficiencies are seen as determining the feasbility of the HTE system, and these high efficiency devices are currently being developed. It is concluded that a proof-of-concept HTE system experiment can and should be conducted.

6782 (PB—86-243722/XAB) **Improved acid electrolytes - the synthesis and structure of fluorine-containing sulfonic acids. Annual report, July 1985-July 1986.** Gard, G.L. (Portland State Univ., OR (USA)). Jul 1986. 22p. NTIS, PC A02/MF A01.

Fourteen fluorosulfonic acids/salts were prepared. Also, nine fluoroesters (precursors to sulfonic acids) were prepared and characterized. Seven acid systems were submitted for evaluation.

6783 **Bubble pressure barriers for molten carbonate fuel cells.** Iacovangelo, C.D.; Karas, B.R. (General Electric Co., Corporate Research and Development Center, Schenectady, NY 12301). *Journal of the Electrochemical Society;* **133**: No. 8, 1595-1600(Aug 1986).

Operation of a molten carbonate fuel cell (MCFC) comprising an anode, a cathode, and a carbonate-filled electrolyte structure is often limited by the development of cracks within the electrolyte structure. This allows mixing of the anode and cathode gases and causes, at best, a deterioration in cell performance. One possible solution to this problem is to incorporate an electrolyte-filled barrier layer, i.e., a bubble pressure barrier (bpb), as an integral part of the electrode structure. Methodologies for the fabrication of anode bpb's from metal-plated ceramics and metal-oxide-impregnated layers are presented. The necessity of tailoring the bpb's physical properties, e.g., pore size distribution, porosity, and microstructure, to those of the other cell components is discussed. Molten carbonate fuel cells containing anode-bpb electrodes and hot-pressed electrolyte structures displayed improved performance relative to those without bpb's. Further, MCFC's that possessed a bpb were capable of withstanding several thermal cycles between 650°C, the cell operating temperature, and 25°C. The slight performance deterioration observed after a thermal cycle is explained by the formation of an internal cell across the anode-bpb composite.

6784 **Performance study of a fuel cell Pt-on-C anode in presence of CO and CO/sub 2/, and calculation of adsorption parameters for CO poisoning.** Dhar, H.P.; Christner, L.G.; Kush, A.K.; Maru, H.C. (Energy Research Corp., Danbury, CT 06813). *Journal of the Electrochemical Society;* **133**: No. 8, 1574-1582(Aug 1986).

A study was undertaken to measure polarization losses due to presence of CO/sub 2/ and CO in the H/sub 2/ fuel for a practical fuel cell Pt/C anode. A porous Pt anode (0.3 mg/cm/sup 2/ Pt) was tested as a floating electrode in a half-cell assembly to measure performance in 100 weight percent H/sub 3/PO/sub 4/ at 190°C in the presence of H/sub 2/ and H/sub 2/, CO/sub 2/, and CO gas mixtures. The additional polarization loss over that of H/sub 2/ due to CO/sub 2/ dilution followed closely the expected loss from the Nernst equation in the range of current density 0-300 mA/cm/sup 2/. The combined loss due to poisoning by CO and the dilution by CO and CO/sub 2/ was analyzed and found to be additive of the poisoning and dilution losses. The poisoning loss by CO was calculated by subtracting the dilution loss from the combined dilution and poisoning loss. Such data were found to be linearly dependent on the logarithm of [CO]/[H/sub 2/] ratio.

6785 **Corrosion of iron in (Li/sub 0.62/K/sub 0.38/)/sub 2/CO/sub 3/ at 650°C.** Hsu, H.S. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 525-526 of Proceedings of the 1986 Spring meeting of the Electrochemical Society. Vol. 86-1. Pennington, NJ; The Electrochemical Society (1986). (CONF-860540—). Contract AC05-84OR21400.

From 169. meeting of the Electrochemical Society; Boston, MA, USA (4 May 1986).

The rapid progress in the development of molten carbonate fuel cells (MCFCs) has highlighted the problem of material compatibility with molten carbonates. A critical cell component in regard to life-time is the current collector, which is in contact with the cathode and oxidant gas on one side and with the anode and fuel gas on the other side. Because of the complexity of fuel cell environments, efforts to understand corrosion of current collector materials began with fundamental considerations of the thermodynamics of metal-carbonate salt systems. Phase stability diagrams were developed for the Cr-Li-K-C-O and Fe-Li-K-C-O systems, and the corrosion of chromium in (Li/sub 0.62/K/sub 0.38/)/sub 2/CO/sub 3/ was studied at 650°C. This paper presents subsequent results on the corrosion of iron under a deposit of the eutectic composition of (Li/sub 0.62/K/sub 0.38/)/sub 2/CO/sub 3/ in simulated fuel cell environments at 650°C.

6786 **Monolithic fuel cells.** Fee, D.C.; Blackburn, P.E.; Busch, D.E.; Claar, T.D.; Dees, D.W.; Dusek, J.; Easler, T.E.; Ellingson, W.A.; Flandermeyer, B.K.; Fousek, R.J. (Argonne National Lab., Argonne, IL 60439). pp 1634-1637 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—). Contract W-31-109-ENG-38.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

A new fuel cell design, called the "monolithic fuel cell", is being developed at Argonne National Laboratory. The monolithic design employs the same ceramic components used in other oxide fuel cells in a strong, lightweight honeycomb structure of small cells with thin walls, and thus can achieve very power per unit mass or volume. The light weigh and low volume, as well as the efficiency and reliability of electrical systems, are advantageous in space systems. Considerable progress has been made in developing monolithic fuel cells. Cells of the monolithic design have been fabricated and operated. High current densities have been achieved. Arrays of the monolithic design having prototypical dimensions have been fabricated are operated.

6787 **Effect of temperature on the adsorption of trifluoromethanesulfonate anions on mercury from constant ionic strength solutions.** Gonzalez, E.R.; Naranjo, R.; Hsueh, K.L.; Srinivasan, S. (Los Alamos National Lab., NM). *Electrochimica Acta;* **28**: No. 2, 165-166(1983).

Since trifluoromethane sulfonic acid ($CF_3SO_3H$, TFMSA) is being considered as a suitable electrolyte for acid fuels cells, a study of the adsorption of trifluoromethane sulfonate anions on mercury electrodes was carried out. The adsorption was studied at 40°C by recorded differential capacity-potential curves as a function of solution composition. The centers of charge of the adsorbed $CF_3SO_3^-$ ions are found to be sufficiently far from the electrodes to

assume that water molecules must be present between the metal and the adsorbed anions. The curves obtained at 40°C are very similar to those obtained at 25°C, and these data are consistent with a current model of a double layer. 4 references, 2 figures.

# 32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

6788 **(BLLD-M—50138) Conversion of an oil-fired boiler to natural gas.** Marx, E. Translated from *Gas Waerme International ;* **28**: No. 12, 726-733(1979). 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901799.

Certain conditions must first be fulfilled if oil-fired boilers are to be converted to operation on natural gas. Substantial differences exist between oil-fired and gas-fired boilers - in the storage, transport and chemical and physical composition of the fuel, in the design of the burner, the mode of combustion and in the composition of the gases produced by the combustion. Before a boiler plant can be converted appropriate investigations should be carried out so that the necessary measures can be taken. Examples of calculations and modifications are given.

## 3201 Buildings

*REFER ALSO TO CITATION(S) 6594, 6633, 6636, 6749, 6869*

6789 **(BNL—38793) Zoned backup in electric-powered heat-pump systems: A way to conserve energy and reduce utility peak loads.** Andrews, J.W. (Brookhaven National Lab., Upton, NY (USA)). Sep 1986. Contract AC02-76CH00016. 11p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002397.

A simple system modification is proposed that will improve the performance of electric-powered heat pumps in cold climates. The proposed modification is to relocate the electric-resistance backup heaters from the central heat pump to the supply-air registers in the individual rooms. The electric resistance backup heat is normally required at very low outdoor temperatures when the heating capacity of the heat pump is less than the building heating load. Moving these backup heaters to the rooms will save energy in two ways: first, by eliminating the duct losses associated with the portion of the heating load that is met by electric resistance backup, and second, by permitting the building to be zoned, with a consequent reduction in heating demand during the coldest portions of the year. Because electric resistance heat is needed when the heating load is greatest, it can result in problematic peak loads to the electric utilities. The energy savings under this concept occur at conditions of peak power usage, which means that the percentage reduction in peak demand will be greater than the percentage reduction in overall electricity use for space heating. Thus, the utility load factor will be improved. A scoping evaluation of the concept for a northern climate of 6900°F days predicted a 43% savings on electric resistance backup heat, 17% reduction of duct losses, 14% savings on total purchased power for space heating, and a 32% reduction of utility peak load.

6790 (CONF-8508111—Vol.2, pp 129-138) **Utilization of computerized models to evaluate energy efficiency design of new buildings.** Myers, M.S.; Diserens, S.E>. (Office of Public Utilities, San Antonio, TX). 1985. NTIS, PC A15/MF A01. File Number DE86011426.

From 2. national conference on energy program evaluation; Chicago, IL, USA (19 Aug 1985).

The City of San Antonio's Office of Public Utilities has developed an innovative process to assess predesign energy conservation strategies for new buildings. This assessment also provides direction for the community's overall economic development objectives. The process utilizes two computer-aided programs to evaluate quickly and cost effectively the energy efficiency of new buildings. The City uses the Predesign Energy Program (PREP) to analyze efficiency in new individual buildings during the conceptual stage of design. The second program, Central Energy Systems Analysis Program (CESAP), analyses energy efficiency for a group of buildings and determines if a new district heating and cooling (HDC) system would be a cost effective application to serve the development project's energy requirements. The combination of these programs has given the City of San Antonio the ability to: (1) help builders, owners, and architects to reduce energy and construction costs, and (2) evaluate the feasibility of new district heating and cooling systems as a means to promote economic development within the City of San Antonio. 5 figures, 2 tables.

6791 (CONF-8605198—, pp vp) **Assurance of quality to prevent water leakage damage.** Roesrud, T. (Norwegian Building Research Inst., Oslo, Norway). 1986. NTIS (US Sales Only), PC A20/MF A01. File Number DE87750096.

From CIB-W62 seminar: water supply and drainage for buildings; Copenhagen, Denmark (12 May 1986).

The cost of repairing water damage of installations has increased by more than 300% during the past 10 years. This year it amounts to $20 mill. pr. mill. inhabitants. Without a combined effort by the Nordic countries the cost would have been even higher. Quality assurance analyses of causes of damage and contractors own investigations have been taken into use. Methods for testing of the quality of materials and design is described. Ageing and lifetime is assessed according to the desire for remplacement and expense if renewal.

6792 **(PB—86-243136/XAB) Hygrothermal tests on timber-framed wall panels with U-values less than 0.3 W/m²k. Research report.** Gaze, A.I. (Timber Research and Development Association, High Wycombe (UK)). 1986. 23p. (RR—5/86). NTIS, PC PC E03/MF E03.

The report covers appropriate standards for higher thermal performance for roofs, walls, and floors of timber-frame housing and to study the possible effects on specification following testing and approval. Appropriate U-values are considered.

6793 **(PB—86-248085/XAB) Market for increased building energy efficiency. Final report.** Harris, D. (National Inst. of Building Sciences, Washington, DC (USA)). Jul 1983. 73p. NTIS, PC A04/MF A01.

The report details the efforts of the National Institute of Building Sciences to increase the rate of investment in cost-effective energy-efficiency improvements in the nation's existing buildings. The objective of the project was to encourage the economic use of energy in existing buildings, to complement market forces and to preserve maximum freedom of choice regarding desired levels of energy efficiency and the means of achieving those levels. The report provides a detailed assessment of the market for building energy-efficiency services and products, existing programs that are aimed at increasing the rate and magnitude of investment in building energy efficiency, and increased expenditures on energy-efficiency improvements through the implementation of these programs.

6794 **Radiative heat pumps using narrow-bandgap semiconductors.** Berdahl, P. (Lawrence Berkeley Lab., CA, USA). *Solar Energy Materials;* **14**: No. 3-5, 437-445(Nov 1986). (CONF-850887—). Contract AC03-76SF00098.

From SPIE international technical symposium on optical and electro-optical engineers; San Diego, CA, USA (18 Aug 1985).

The solid state radiative heat pump (SSRHP) concept is introduced. It offers the potential to pump infrared radiation, for heating and cooling, with high second law efficiency. In particular, some of the limitations of Peltier-effect heat pumps can be circumvented. Two approaches for constructing SSRHP devices are described. In one approach the device is a large-area p-n junction, similar to an IR (light) emitting diode. In the second approach one uses orthogonal electric and magnetic fields to alter equilibrium carrier concentrations of electrons and holes near the crystal surface, altering the IR emission due to electron-hole recombination radiation. This phenomenon is usually termed galvanomagnetic luminescence (GML). Either approach can be used to make radiative heat pumps. Materials suitable for SSRHP devices are narrow-bandgap semiconductors with direct bandgaps in the range of 0.03-0.3 eV for room temperature operation. Obvious candidates are InSb, Hg/sub 1-x/Cd/sub x/Te and Pb/sub 1-x/Sn/sub x/Te. As a first step in the evaluation of InSb, absolute spectral measurements of its galvanomagnetic luminescence were made. These and related

measurements in Russia, Japan and Germany are discussed. 4 figs., 11 refs.

6795 **Annual performance of a horizontal-coil ground-coupled heat pump.** Johnson, W.S.; McGraw, B.A.; Conlin, F.; Wix, S.D.; Baugh, R.N. (The Univ. of Tennessee Energy, Environment, and Resources Center). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1A, 173-185(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

Performance of the ground-coupled heat pump system located in TECH House I at the University of Tennessee has been measured for the 1983-84 cooling and heating seasons. Hourly measurements of heat flows, power consumptions, and various ground, space, and system temperatures have been recorded and analyzed to give overall seasonal performance. For the heating season, the performance factor was found to be 2.6, which is higher than a typical air-air system. However, performance factor for the cooling season was determined to be only 1.1, considerably lower than a typical air-air system. Reasons for this low performance in the cooling mode include poor backfilling procedure when the ground coil was buried, soil drying, and possibly too short a ground coil. Also, the heat pump system itself had a low coefficient of performance for cooling compared to other high-efficiency systems. Future work on this project will involve reinstallation of a longer ground coil with better backfill, the installation of a ground irrigation system, a more efficient heat pump, and eventually the optimization of the ground coil and heat pump system.

6796 **U-value measurements for windows and movable insulations from hot box tests in two commercial laboratories.** McCabe, M.E.; Ducas, W.; Cholvibul, R.W.; Wormser, P. (National Bureau of Standards). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1A, 453-473(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

Different laboratory tests and procedures (ASTM C236, ASTM C976, and AAMA 1503.1) are discussed in the context of measuring U-values of direct gain fenestration (DGF) components such as windows and movable insulation for windows. Four representative DGF components, including a multiple-glazed window and three single-glazed windows with movable insulation systems, were purchased and prepared for testing. U-Values were measured for each test component at two commercial testing laboratories using the ASTM C236 and the AAMA procedures for a range of simulated outdoor conditions. Difficulties were experienced by one test lab in calibration testing of a low-conductance test frame and in testing at nonstandard conditions. When the test results from this lab were recalcuatled, meaningful comparison between the results from the different laboratories was possible.

6797 **Comparison of numerical model with ashrae design procedure for warm water concrete floor heating panels.** Hogan, R.E.; Blackwell, B.F. (Mechanical Engineering Dept., Texas A&M Univ., College Station and Centrifuge, Climatic and Radiant Heat Div., Sandia National Labs., Albuquerque, NM). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1B, 589-602(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

The ASHRAE design recommendations for radiant heating panels are reviewed and evaluated using results computed from numerical mode. The panel configuration that was considered consists of hot water pipes buried in either a bare or a covered concrete slab floor with a concrete footing and perimeter insulation. The numerical model is described in detail and uses a finite control volume based solution method. Particular parameters of interest are the downward and edgewise heat loss, the panel thermal resistance, and the required mean water temperature. Results of the numerical model were compared with prior experimental results and agree qualitatively. The ASHRAE design recommendations are shown to be adequate and are slightly conservative for designing both rare and covered floor heating panels with no infiltration and with an area-weighted average unheated surface temperature (AUST) equal to the room air temperature. The ASHRAE design recommendations are conservative because both the downward and edgewise heat loss and the panel thermal resistance are overestimated.

6798 **Design and preliminary analysis for measuring transient mass rate of flow in unitary heat pumps.** Belth, M.I.; Tree, D.R. (Magnavox Electric Systems Co., Fort Wayne, IN). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* 92: No. 1B, 843-856(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

Because of the time and expense involved in building and testing prototype heat pumps, mathematical models of heat pumps have been developed. These models and experimental work show that refrigerant movement and/or migration during start-up, shut-down and frosting-defrosting is an important parameter. Little information is known about this movement. Therefore, good experimental data of mass flow rate into and out of each component of the heat pump during these transient time are needed. Unfortunately, no mass flow meter exists that can currently measure two-phase flow rates. This paper describes the system designed, the major problem encountered, and gives some preliminary results of a system to continuously measure the change in refrigerant mass in the evaporator, condenser, accumulator and compressor of a heat pump during both start-up and shut-down conditions. With these measurements, knowing the total charge in the system and measuring with a conventional flow meter the mass rate of flow leaving the compressor, the mass rate of flow entering and leaving each component (including liquid lines) can be determined.

## 3202 Transportation

*REFER ALSO TO CITATION(S) 6681, 6742, 6744, 6778, 6986*

6799 **A novel heat rejection system for space applications: The Curie Point Radiator.** Carelli, M.D.; Gibson, G.; Wright, F.; Markley, R.A.; Schmidt, J.E.; Flaherty, R. (Westinghouse Advanced Energy Systems Div., Madison, PA 15663). pp 1875-1880 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The Curie Point Radiator (CPR) is an advanced radiator concept which offers unique advantages in terms of possible improvements in space power system efficiencies, reduced radiator mass requirements and increased reliability for multi-megawatt space power applications. The operating principle of the CPR is to transfer the waste heat to small size ferromagnetic particles which are heated above their Curie point to a non-magnetic state and released into space. As the particles lose heat by radiation and their temperature drops below the Curie point, they become ferromagnetic again, are contained by a magnetic field and driven to a collector for recycle. Presented here are the unique advantages of this concept and the preliminary results of a feasibility study which show that the CPR is indeed capable of providing a reliable, low mass radiator system for future space stations.

6800 **Heat pipe design for space power heat rejection applications.** Merrigan, M.A. (Los Alamos National Lab., Los Alamos, NM 87545). pp 1993-1998 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Heat pipe radiators represent the current state-of-the-art in heat rejection systems for space power applications. Design trends in high temperature systems are to higher power applications with necessarily larger radiators. In these systems the usable length of radiation loaded heat pipe elements and the temperature distribution for long heat pipe elements are both of concern. The work report-

ed herein is concerned with analysis of sodium and potassium heat pipe radiator elements operating in the 700 K to 1600 K temperature range. Useful lengths of radiator elements are identified as a function of the operating temperature and heat pipe diameter for a given working fluid. Required evaporator areas for the heat pipe designs are identified based on demonstrated radial flux values. Together the radial and axial parameters define the heat pipe radiator configuration. In these analyses the individual heat pipes are assumed to radiate with an emissivity of 0.9 to a zero degree heat sink. Area for the heat rejection is based on the circumference of the heat pipe. The analysis shows that potassium heat pipe radiator element lengths of more than 20 m are achievable at temperatures of 1000 K with heat pipe diameters of less than 10 cm. For sodium heat pipes at 1200 K lengths of almost twice this are shown to be usable.

6801 **Design of a high-power-density Ljungstrom turbine using potassium as a working fluid.** Coomes, E.P.; Dodge, R.E.; Wilson, D.G.; McCabe, S.J. (Pacific Northwest Lab., Richland, WA 99352). pp 2020-2025 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The ability to generate large quantities of high-quality power in space will be necessary to meet the needs of many proposed future space programs. The Pacific Northwest Laboratory is studying an advanced multi-megawatt space power system employing a liquid metal Rankine power cycle. This paper examines more closely one component of the system, the power turbine. The turbine design selected for this system is a counter-rotating radial-outflow machine developed in the early twentieth century by two brothers, Fredrik and Birger Ljungstrom. The Ljungstrom turbine was selected because it provides a compact, high-power-density turbine with balanced rotational inertia and is tolerant of moisture in the working fluid. In commercial operation, Ljungstrom turbines have demonstrated excellent rapid start capabilities and good overall efficiency. Moreover, the disadvantages that have hindered its use in conventional power plants are tied to the steam's very large change in specific volume. These disadvantages are circumvented in a machine using potassium for a working fluid. A preliminary design study indicates that high-power Ljungstrom turbines, using potassium as a working fluid, are feasible, and that Ljungstrom turbines of 200 MW and greater could easily fit into the cargo bay of the space shuttle.

## 3203 Industry And Agriculture

*REFER ALSO TO CITATION(S) 6455, 6769, 6887*

6802 **(CONF-861008—1) Development of a membrane alkaline fuel cell for caustic concentration in the chlor-alkali industry.** Taylor, E.J.; Gelb, A.; Waterhouse, R. (Physical Sciences, Inc., Andover, MA (USA)). 1986. Contract FC07-84ID12495. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001457.

From Fuel cell seminar; Tucson, AZ, USA (26 Oct 1986).

Nafion 901 and seven DuPont developmental membranes have been studied for the chlorine/caustic soda production process. Initial screening in 30 wt % anolyte/catholyte and 25 wt % NaOH anolyte/40 wt % NaOH catholyte has indicated the DuPont development membrane A1 to be the most promising. To date, the performance of an advanced cation exchange membrane has been demonstrated. (DLC)

6803 **(DOE/BP/15104—1) Sawmill electrical energy study, Phase 1.** (Carroll, Hatch and Associates, Inc., Portland, OR (USA)). Oct 1984. Contract AC79-84BP15104. 149p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87002228.

Purpose of this project was to conduct an in-depth study of electrical energy consumption in a representative sawmill. The study was conducted at the sawmill at the Frank Lumber Company, Inc. in Mill City, Oregon. The potential energy savings of identified energy conservation measures (ECMs) was calculated to be just over 1.3 million kWh annually or approximately 15% of the mill's total energy consumption. This figure corresponded favorably with pre-study estimates of over 1.6 million kWh, or 18% of total energy consumption. Despite the current low cost of electric power in the region, a number of ECMs were identified that offer cost-effective investment opportunities. For example, one ECM identified - the properly timed reduction of fan-powered air flow in the mill's dry kilns - could provide a savings of 0.5 to 0.8 million kWh on an annual basis.

6804 **(DOE/ID/12428—1) Countercurrent heat exchange between a gas and vibrofluidized solid. Final technical report.** Squires, A.M.; Liu, Y.A. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemical Engineering). 31 May 1986. Contract FG07-83ID12428. 289p. NTIS, PC A13/MF A01; 1; GPO Dep. File Number DE87002073.

A pilot-scale flowing vibrofluidized-bed heat exchanger has been successfully designed, constructed and tested. By using a factorial design of experiments, a higher heat transfer coefficient from a "supernatant" hot air to a flowing vibrofluidized bed of Norton Master Beads was obtained with higher air flow rates, lower baffle heights and higher vibrational intensities. The solid flow rate had an insignificant effect on the heat transfer. Tests with multiple baffles led to a maximum air-to-solid heat transfer coefficient of 270 $W/m^2$-K. An economic evaluation showed that the proposed vibrofluidized-bed heat exchanger would be economically feasible for preheating the boiler feedwater using heat recovered from hot combustion gases. The payback time for the system could be as short as 1.4l years. Significant progress has also been made towards better understanding of the mechanisms of vibrofluidization and heat transfer in vibrofluidized beds. Through the use of video-recording, strobe lighting, colored tracer particles, phase-shift photography and instantaneous floor-pressure measurements, important new insights were obtained on the bed structures, solid circulation patterns and air gap formations, along with their effects on bed-to-surface heat transfer, in stationary vibrofluidized beds. In addition, a new computerized heat-probe system capable of maintaining essentially a constant probe-surface temperature has also been developed. Under optimum conditions tested, a very high bed-to-surface heat transfer coefficient of nearly 500 $W/m^2$-K was obtained. Experimental results and operational experience from both stationary and flowing vibrofluidized-bed systems have suggested certain design improvements for enhancing the heat recovery performance of the proposed vibrofluidized-bed heat exchanger.

6805 **(DOE/ID/12521—1) Conversion of polyester/cotton industrial wastes to higher value products: Final report.** Cates, D. (North Carolina State Univ., Raleigh (USA). Dept. of Textile Chemistry). 30 Oct 1986. Contract AC07-84ID12521. 59p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002509.

Several polyster/cotton waste blends were successfully used as feedstock to make injection molded products. Nucleating and plasticizing additives (commonly required in the production process) were found to be unnecessary; their functions were fulfilled by the cotton component of the waste feedstock. The properties of the injection molded parts were comparable generally to those of a great many other plastics. Cotton caused a notable increase in stiffness (modulus) of the molded part, but failed to produce a significant increase in tensile strength. Plant trials revealed difficulties that were unobserved in the smaller scale runs: sticking in the mold, release of water and other volatiles at the molding temperature, and intermittent flow. Sticking in the mold probably can be solved by including a small amount of mold release compound in the formulation just prior to pelletization. The problems of release of volatiles and intermittent flow can possibly be solved. Polyester/cotton molded products would have a price advantage as feedstock in the commodity thermoplastics market, but it is possible that this could be dissipated by higher molding costs.

6806 **(GB—45) Waste heat: recovery and utilisation symposium.** (Institute of Energy South Coast Branch, Fareham (UK)). 1986. 162p. (CONF-8509340—). BLDSC, Boston Spa, Wetherby, West Yorks.

From Waste heat: recovery and utilization symposium; Portsmouth, UK (25 Sep 1985).

Symposium contributions presented cover rotary air preheaters on power station boilers, shell and tube heat exchangers, economisers for gas fired boilers and recuperative and regenerative burners. Heat recovery, potential energy savings identified by government assisted studies, heat pumps, air-to-air energy recovery, high temperature waste heat recovery and government policy are reviewed.

6807 **The selection and testing of plastic tower fill.** Blue, S.C. Houston, TX; Cooling Tower Institute (1986). 26p. (CONF-860169—). Cooling Tower Institute, 9030 IH-45 North Room 216, Gulfbank Road Exit, Houston, TX 77037. Contract AC05-84OR21400.

From Annual meeting of the Cooling Tower Institute; Houston, TX, USA (27 Jan 1986).

The Paducah Gaseous Diffusion Plant operates four recirculating water loops to control the temperature of the uranium enrichment process. In 1973, the performance of four counterflow towers was significantly improved when the aging wooden slat fill was replaced with 130,000 cubic feet of asbestos paper cellular fill. In anticipation of a need to make another fill change at some future date, a program was initiated to maintain an awareness of new fill products and investigate their physical durability. The problems that had been encountered in obtaining large quantities of asbestos paper fill and the development and availability of plastic fill led the Technical Services Division of the Paducah Plant into a long-term study of plastic cooling tower fill. The form of the program evolved from investigations of materials and the heat resistance of fill products to measurement of the tower fill temperature gradients and analysis of potential heat loads.

### 3206 Municipalities And Community Systems

*REFER ALSO TO CITATION(S) 6583, 6586*

6808 **(ANL/CNSV-TM—180) Fundamentals of direct liquefaction of municipal solid waste in a semicontinuous, microprocessor-controlled autoclave.** White, D.H.; Wolf, D.; Joshi, D.; Kim, W.J.; Zhao, Y. (Arizona Univ., Tucson (USA)). Jul 1986. Contract W-31-109-ENG-38. 142p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87002347.

The program was initiated in March 1984 and consisted of modifying existing autoclave and a real-time digital microprocessor control system so that it could be operated in a semi-continuous mode. This consisted of controlling inlet gases and outlet gases continuously during the MSW liquefaction in the autoclave. The various components of MSW were studied in order to obtain meaningful data, not confused by the different thermokinetics of more than one distinct MSW component. Feedstocks included wood flour, cardboard, newsprint and rice (starch), as well as the important model compounds $\alpha$-cellulose and lignin. It was found that these MSW components could be converted to liquid oils and a high-heating value residual solid at temperatures of 325°C to 400°C and pressures of 1000 psi to 3000 psi. This is a temperature level of about 100°C lower than that required for coal liquefaction. This one-year research program proved the feasibility of converting MSW to liquid fuel products and solid fuel by-products of high heating values.

## 33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

6809 (N—86-28407, pp vp) **Electrodynamics panel presentation.** Mccoy, J. Jun 1986. NTIS, PC A25/MF A01. (NASA-CP—2422-VOL-1; NAS—1.55:2422-VOL-1; CONF-8510374—Vol.1).

From Workshop on applications of tethers in space; Venice, Italy (15 Oct 1985).

The Plasma Motor Generator (PMG) concept is explained in detail. The PMG tether systems being used to calculate the estimated performance data is described. The voltage drops and current contact geometries involved in the operation of an electrodynamic tether are displayed illustrating the comparative behavior of hollow cathodes, electron guns, and passive collectors for current coupling into the ionosphere. The basic PMG design involving the massive tether cable with little or no satellite mass at the far end(s) are also described. The Jupiter mission and its use of electrodynamic tethers are given. The need for demonstration experiments is stressed.

### 3301 Internal Combustion Engines

*REFER ALSO TO CITATION(S) 6496*

6810 **(PB—86-248028/XAB) Marine Diesel-Engine Fuel Cost and Quality-Analysis/Selection Program. Volume 1. Executive summary. Report for October 1984-April 1986.** Roessler, E.; Shumski, G. (Seaworthy Systems, Inc., Essex, CT (USA)). Apr 1986. 13p. NTIS, PC A02/MF A01.

The document presents an Executive Summary of a microcomputer-based Marine Diesel-Fuel Cost and Quality-Analysis/Selection Program that can be utilized to evaluate and select a fuel for bunkering on the basis of cost per unit heat content in dollars per million Btu, $/MBtu, versus the more traditional method of price per unit volume or weight, referenced to viscosity. In addition, the program evaluates and identifies, based on the pre-purchased quoted fuel properties, fuels with potentially harmful contaminants.

6811 **(PB—86-248036/XAB) Marine Diesel-Engine Fuel Cost and Quality Analysis/Selection Program. Volume 2. User's guide. Report for October 1984-April 1986.** Roessler, E.; Shumski, G. (Seaworthy Systems, Inc., Essex, CT (USA)). Apr 1986. 124p. NTIS, PC A06/MF A01.

The document presents a Users Guide for a microcomputer-based Marine Diesel Fuel Cost and Quality Analysis/Selection Program which can be utilized to evaluate and select a fuel for bunkering on the basis of cost per unit heat content in dollars per million BTU, $/MBTU, versus the more traditional method of price per unit volume or weight, referenced to viscosity. In addition, the program will evaluate and identify, based on the pre-purchased quoted fuel properties, fuels with potentially harmful contaminants.

6812 **CARS temperature measurements in the unburned gas region of an internal combustion engine.** Lucht, R.P.; Green, R.M.; Palmer, R.E.; Ferguson, C.R. (Sandia National Labs., Combustion Research Facility, Livermore, CA 94550). pp 360 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Broadband coherent anti-Stokes Raman scattering (CARS) temperature measurements have been performed in the unburned gas region of an internal combustion engine. At the temperatures and pressures of interest, it is difficult to measure temperature accurately because temperature information is contained primarily in the shape of the nitrogen fundamental band, which is significantly affected by collisional narrowing. The results of the CARS measurements are compared to the predictions of a detail engine heat release model. Such heat release models are widely used in the automotive industry to predict engine performance and efficiency. The temperature predictions of such models have not, to the author's knowledge, previously been compared to spatially and temporarily resolved temperature measurements in operating engines.

### 3303 Electric-powered Systems

*REFER ALSO TO CITATION(S) 6753, 6754, 6756*

## 36 MATERIALS

6813 **Shock waves in condensed matter.** Gupta, Y.M. New York, NY; Plenum Press (1986). 954p. (CONF-850736—). Plenum Publishing Corp., New York, N.Y.

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This conference on Shock waves in condensed matter presents information on the following topics: equation of state; optical studies; dynamic fracture and fragmentation; experimental developments; hydrodynamics; material synthesis; and energetic materials. Specific papers presented include: theory of the high temperature shocked metallic state; shock Hugoniot equation of state-electron band theory approach; Raman spectroscopy of shocked water; molecular emission spectra from shock-decomposed benzene; constitutive relation for 6061T6 aluminum under shock loading conditions; rapid cavitation induced by the reflection of shock waves; laser interferometer measurements of refractive index in shock-compressed materials; application of shock wave data to Earth and planetary science; experimental techniques for measuring mass ejection from shock-loaded metallic sample; chemical synthesis under high pressure shock loading; and rate-determining steps for ignition of shocked nitromethane.

## 3601 Metals And Alloys

*REFER ALSO TO CITATION(S) 6651, 6655, 6735, 6785, 6877, 6947, 7806*

6814 **(AD-A—171624/0/XAB) Fundamental studies on the aluminum-lithium-Beryllium alloy system. Final report, February 1984-August 1986.** Wadsworth; Nieh, T.G.; Vidoz, A.E.; Lewis, R.E.; Joshi, A. (Lockheed Missiles and Space Co., Inc., Palo Alto, CA (USA). Research and Development Div.). Aug 1986. 133p. (LMSC-D—067295). NTIS, PC A07/MF A01.

Recent developments in aluminum alloys for aerospace applications have emphasized low-density alloys and, in large part, this emphasis has been on Al-Li based alloys. The development of fine-structed Al-Li-Be alloys remains an interesting prospect for further decreasing the density and increasing the modulus of Al. The aging behavior of rapidly solidified Al-10%Be-3%Li ribbon was characterized. Several conclusions can be made from this study. The general aging characteristics of the ternary Al-Be-Li alloys are very similar to binary Al-Li alloys. Although delta-prime precipitates are present in the as-spun ribbon, uniform delta prime distribution was not observed until aging temperatures of about 180°C. Heat treatment of the ribbon at higher temperatures, e.g., 300°C resulted in delta-prime transformation. In the Al-Be-Li ternary, the alpha-Be particles are present in the Al-Li matrix as independent dispersoids and have little effect on the aging response of the Al-Li matrix. The size of the distribution of the alpha-Be particles is nonumiform. Upon heat treatment at temperatures higher than 300°C, alpha-Be particles tend to coarsen and the growth behavior of these particles follows a classical Ostwald coarsening mechanism.

6815 **(AD-A—171917/8/XAB) Effect of thermomechanical processing variables on ductility of a high-Mg, Al-Mg-Zr alloy. Master's thesis.** Grider, W.H. (Naval Postgraduate School, Monterey, CA (USA)). Jun 1986. 78p. NTIS, PC A05/MF A01.

In previous research on thermomechanically processed high-Mg, Al - Mg alloys, yield strengths of 276 MPa (40 ksi) were retained after simulated superplastic forming, but ductility at ambient temperature varied from 1 to 14% elongation in tension testing. This variability in ductility was studied in a series of experiments conducted on an Al-10%Mg-0.1%Zr alloy. Study by light microscopy and scanning electron microscopy revealed defects resulting from inverse segregation in the original casting and also defects resulting from the relatively light reductions utilized in the warm rolling of the material. The use of heavier reductions in rolling was shown to improve tensile ductility at ambient temperature both in the as-rolled and annealed conditions. Superplasticity in material processed using such heavier reductions in rolling was then studied by tension testing at 300 C.

6816 **(AERE-R—11147) Stochastic models of pitting corrosion of stainless steels: Part 2, Measurement and interpretation of data at constant potential.** Williams, D.E.; Westcott, C.; Fleischmann, M. (UKAEA Atomic Energy Research Establishment, Harwell. Materials Development Div.). May 1984. 36p. NTIS (US Sales Only), PC A03. File Number DE87900115.

The experimental evaluation of the parameters of a general stochastic model for the initiation of pitting corrosion on stainless steels is described. The variation of these parameters with experimental conditions is used in the development of a microscopic model. A microscopic model which accords with the observed behavior attributes the initiation of pitting corrosion to the production and persistence of gradients of acidity and electrode potential on the scale of the surface roughness of the metal. The observed fluctuations are related to fluctuations in the hydrodynamic boundary layer thickness. A pit becomes stable when it exceeds a critical depth, related to the surface roughness.

6817 **(BNL—38702) Effects of Na on the interaction of CO with Ta(110).** Shek, M.L.; Pan, X.; Strongin, M. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 23p. (CONF-861019—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001468.

From 10. international vacuum congress and 6. international conference on solid surfaces and the 33. national symposium of the American Vacuum Society; Baltimore, MD, USA (27 Oct 1986).

The interaction of CO with Ta(110) at 80K proceeds by dissociative chemisorption followed by molecular adsorption. The molecular chemisorption bond strength is weak, as judged by the observation in photoemission spectra of a "shake-up" feature at 2.1 to 2.2 eV below the "4$\sigma$" orbital. The weakly bound molecular phase continues to exist in the presence of Na predoses, apparently without appreciable adsorption bond strengthening. This molecular phase is suppressed in favor of dissociation only after predoses of ~1.0 and ~1.29 ML Na, when a small to moderate enhancement in CO dissociation occurs relative to the pure surface at 80K.

6818 **(BNL—38756) Computer modeling of magnetic flux pinning by grain boundaries in high-field superconductors.** Welch, D.O.; Ghosh, V.; Lazareth, O.W. Jr.; Hatcher, R.D. (Brookhaven National Lab., Upton, NY (USA); Queens Coll., Flushing, NY (USA)). 1986. Contract AC02-76CH00016. 4p. (CONF-860914—9). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001460.

From Applied superconductivity conference (ASC '86); Baltimore, MD, USA (28 Sep 1986).

We report here some results for the critical current density of a high-field superconductor such as $Nb_3Sn$ calculated with a simple two-dimensional model using computer simulation methods similar to those of Brandt and utilizing an expression for the magnetic flux line-grain boundary interaction energy derived by Welch based on the electron-scattering mechanism.

6819 **(CEA-CONF—8418) Pure niobium sheet formability limits hydroforming.** Collard, J.; Daumas, M.T. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). Apr 1986. 6p. (In French and English). (CONF-8604260—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750239.

From 14. international deep drawing research group biennal (IDDRG-14); Koeln, F.R. Germany (21 Apr 1986).

Sheets of niobium of 3 different thicknesses (0.1 mm, 1 mm and 2 mm) are deep-drawn by isostatic forming, influence of plane anisotropy and thickness are studied and deformation of the hydroformed niobium is observed. Forming limit curves are determined.

6820 **(CONF-860746—11) Purification of $CeCu_6$ single crystal.** Onuki, Y.; Shibutani, K.; Yamazaki, T.; Komatsubara, T.; Maezawa, K.; Wakabayashi, S. (Argonne National Lab., IL (USA); Tsukuba Univ., Sakura, Ibaraki (Japan). Inst. of Materials Science; Toyama Univ. (Japan)). Jun 1986. Contract W-31-109-ENG-38. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001538.

From Anomalous rare earths and actinides; Grenoble, France (7 Jul 1986).

The growth and purification of $CeCu_6$ single crystals and their charcterization by electrical resistivity and magnetoresistance are described.

**6821 (CONF-8606101—9) Slip band distribution and morphology in cyclically deformed nickel polycrystals with ion beam mixed surface films.** Grummon, D.S.; Jones, J.W.; Eridon, J.; Was, G.S.; Rehn, L.E. (Argonne National Lab., IL (USA); Michigan Univ., Ann Arbor (USA)). Aug 1986. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001556.

From 5. international conference on ion beam modification of materials; Catania, Italy (9 Jun 1986).

It is shown that surface modification by ion beam mixing produces potentially beneficial effects on cyclic deformation phenomena associated with fatigue crack initiation. The principal effects of the modifications are to suppress the formation of the notch-peak surface topography of persistent slip bands (PSBs) and inhibit the net extrusion of PSBs from the free surface. The dominant "failure mode" of the surface is changed from extrusion and notch formation to surface film rupture.

**6822 (DOE/AL/18071—T6) Research and development study for optimization of beryllium production operations. Task V. Final report.** Kaczynski, D.J. (Brush Wellman, Inc., Elmore, OH (USA)). Jul 1986. Contract AC04-82AL18071. 139p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87001859.

Purpose of this project was to thoroughly investigate the existing beryllium production process and compare it to alternate beryllium-making processes. Goal was to determine the state-of-the-art technology for economic production of beryllium metal in an environmentally satisfactory manner to meet the future strategic needs of the United States. Work completed during this study included (1) a review of the existing beryllium-making process with implementation of recommendations which were thought to improve the process from either an environmental or economic standpoint, (2) a detailed literature study for new beryllium processing technologies, and (3) the design, construction, and operation of a number of demonstration models testing new technologies for beryllium processing.

**6823 (DOE/AL/18071—T10) Research and development study for optimization of beryllium production operations. Tasks III and IV reports. Construction and operation of demonstration models.** (Brush Wellman, Inc., Elmore, OH (USA)). Jul 1986. Contract AC04-82AL18071. 353p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE87001858.

The objective of this program, the production of a spherical, fine particle, low oxide content beryllium powder by inert gas atomization, was successfully met. The initial step toward achieving the objective, the construction of an atomization unit, was followed by the development of a procedure to successfully produce a spherical powder by atomization. Twenty-nine atomization runs were made to characterize the effects of atomization variables upon the product powder. The variables investigated were melt superheat, nozzle diameter, atomization pressure, and atomization gas oxygen level. Under the range of process conditions used, -200 mesh yield varied from 3.96% to 26.26%. After the powder was produced, a procedure to remove the excess iron contamination, resulting from atomizer design deficiencies, was developed. The cleaning procedure limited the iron to an additional 400 ppM in addition to 500 ppM pre-existing in the melt stock. Good powder flow and high packing density, about 64% of theoretical, helped reduce billet distortion during consolidation. This is economically important for near-net-shape technology. The spherical powder was successfully consolidated by hot isostatic pressing (HIP) and vacuum hot pressing (VHP). Tensile properties of a fully dense HIP'd specimen showed excellent isotropy, high 0.2% yield strength (37.7 ksi), high ultimate strength (51.5 ksi), and good ductility (2.5% elongation). X-ray pole figure analysis showed a complete absence of preferred crystallographic orientation.

**6824 (DOE/CE/15200—T2) Effective passivating oil field corrosion control system. Final technical report.** Kauffman, D.; Gay, R.J. (New Mexico Univ., Albuquerque (USA)). 31 Mar 1986. Contract FG01-85CE15200. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011480.

The effective passivating corrosion control system discovered and developed by Mr. Richard Gay was successfully tested under severely corrosive conditions: temperature to 250°C, 1% NaCl, pH 4.5, with 0.018 M $CO_2$ and 0.054 M $H_2S$. A hard, corrosion-resistant film was deposited on steel test coupons, and further corrosion was prevented. Potential applications for the system include sour oil and gas wells and gathering systems, geothermal wells and gathering systems, gas processing plants and refineries. Ultimate commercial development will require additional field and laboratory test work.

**6825 (DOE/ER/10508—T3) Deformation mechanisms and failure modes in superplasticity. Final summary report.** Mukherjee, A.K. (California Univ., Davis (USA). Dept. of Mechanical Engineering). 26 Mar 1986. Contract AS03-79ER10508. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001871.

Deformation mechanisms were investigated in the following alloys: Zn-22 Al eutectoid, a copper-based alloy, IN744 microduplex stainless steel, and 7475-T6 aluminum alloy. (DLC)

**6826 (DOE/ER/45162—2) [A study of the interaction of light with submicron metallic surfaces]: Progress report.** Reifenberger, R. (Purdue Univ., Lafayette, IN (USA). Dept. of Physics). Oct 1986. Contract FG02-84ER45162. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002521.

The fundamental physical process studied is the photoexcitation of electrons from field emission tips by a focused argon-ion laser beam tuned to operate at a specific photon energy. The photoexcited electrons escape into the vacuum by tunneling through a surface potential barrier which is distorted by the application of a strong electric field. The primary interest in these experiments lies in a better understanding of the photoexcitation process at low photon energies. The techniques under development directly measure the excited state energy distribution of electrons that are emitted through the surface potential barrier. In addition, we are attempting to exploit the field emission microscope to study laser-induced diffusion of atomic species. The basic information gained from this research should be relevant for the better design and fabrication of opto-electronic and infrared devices which rely on photoexcitation of electrons in the presence of interface electric fields for their operation. 3 figs.

**6827 (HEDL-SA—3296-FP) General corrosion studies of candidate container materials for the basalt waste isolation project.** Lutton, J.M.; Brehm, W.F.; Maffei, H.P.; Rivera, C.L.; Anantatmula, R.P. (Westinghouse Hanford Co., Richland, WA (USA); Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Sep 1985. Contract AC06-76FF02170. 12p. (CONF-850918—16). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000187.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The general corrosion studies program consists of three types of tests to determine the corrosion behavior of candidate container materials for the Basalt Waste Repository. Air/Steam tests simulate conditions in the repository operating period, and static and refreshed pressure vessel tests simulate post-closure conditions. Copper and iron-base alloys and their weldments are being tested. Weight loss and surface analysis data from two short-term tests are reported. In these, the effect of weldments in static groundwater, and that of packing material in air/steam environment were studied. Early results from long-term testing are alos included.

6828 **(N—86-28164) Micromechanisms of thermomechanical fatigue: a comparison with isothermal fatigue.** Bill, R.C. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 21p. (NASA-TM—87331; E—3075; NAS—1.15:87331; USAAVSCOM-TR—86-C-7; CONF-8606200—2). NTIS, PC A02/MF A01.

From SFM international spring meeting on high-temperature fatigue; Paris, France (9 Jun 1986).

Thermomechanical Fatigue (TMF) experiments were conducted on Mar-M 200, B-1900, and PWA-1480 (single crystals) over temperature ranges representative of gas turbine airfoil environments. The results were examined from both a phenomenological basis and a micromechanical basis. Depending on constituents present in the superalloy system, certain micromechanisms dominated the crack initiation process and significantly influenced the TMF lives as well as sensitivity of the material to the type TMF cycle imposed. For instance, high temperature cracking around grain boundary carbides in Mar-M 200 resulted in short in-phase TMF lives compared to either out-of-phase or isothermal lives. In single crystal PWA-1480, the type of coating applied was seen to be the controlling factor in determining sensitivity to the type of TMF cycle imposed. Micromechanisms of deformation were observed over the temperature range of interest to the TMF cycles, and provided some insight as to the differences between TMF damage mechanisms and isothermal damage mechanisms. Finally, the applicability of various life prediction models to TMF results was reviewed. Current life prediction models based on isothermal data must be modified before being generally applied to TMF.

6829 **(N—86-28165) Compressive creep behavior of alloys based on $B_2FeAl$.** Mantravadi, N.; Vedula, K.; Gaydosh, D.; Titran, R.H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 16p. (NASA-TM—87293; E—3000; NAS—1.15:87293; CONF-860340—10). NTIS, PC A02/MF A01.

From 115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting; New Orleans, LA, USA (2 Mar 1986).

Alloys based on FeAl are attractive alternate materials for environmental resistance at intermediate temperatures. Addition of small amounts of Nb, Hf, Ta, Mo, Zr, and B were shown to improve the compressive creep of this alloy at 1100 K. Boron, in particular, was found to have a synergistic effect along with Zr in providing properties substantially better than the binary alloy. This improvement seems to be related to the higher activation energy found for this alloy, suggesting a modification in the diffusion behavior due to the alloying additions.

6830 **(N—86-28462) Formulation of the nonlinear analysis of shell-like structures, subjected to time-dependent mechanical and thermal loading. Interim technical report, 15 April 1984-14 April 1986.** Simitses, G.J.; Carlson, R.L.; Riff, R. (Georgia Inst. of Tech., Atlanta (USA)). Jul 1986. 178p. (NASA-CR—177194; NAS—1.26:177194). NTIS, PC A09/MF A01.

A general mathematical model and solution methodologies for analyzing the structural response of thin, metallic shell structures under large transient, cyclic, or static thermomechanical loads was sought. Among the system responses associated with these loads and conditions are thermal buckling, creep buckling, and ratcheting. Thus geometric and material nonlinearities (of high order) can be anticipated and must be considered in developing the mathematical model. A complete, true ab-initio rate theory of kinematics and kinetics for continuum and curved thin structures, without any restriction on the magnitude of the strains or the deformations, was formulated. The time dependence and large strain behavior are incorporated through the introduction of the time rates of metric and curvature in two coordinate systems: fixed (spatial) and convected (material). The relations between the time derivative and the covariant derivative (gradient) was developed for curved space and motion, so the velocity components supply the connection between the equations of motion and the time rates of change of the metric and curvature tensors. A time and temperature dependent viscoplasticity model was formulated to account for finite strains and rotations.

6831 **(N—86-28464) Thermal-fatigue and oxidation resistance of cobalt-modified Udimet 700 alloy.** Bizon, P.T.; Barrow, B.J. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Apr 1986. 15p. (NASA-TP—2591; E—2704; NAS—1.60:2591). NTIS, PC A02/MF A01.

Comparative thermal-fatigue and oxidation resistances of cobalt-modified wrought Udimet 700 alloy (obtained by reducing the cobalt level by direct substitution of nickel) were determined from fluidized-bed tests. Bed temperatures were 1010 and 288 C (1850 and 550 C) for the first 5500 symmetrical 6-min cycles. From cycle 5501 to the 14000-cycle limit of testing, the heating bed temperature was increased to 1050 C (1922 F). Cobalt levels between 0 and 17 wt% were studied in both the bare and NiCrAlY overlay coated conditions. A cobalt level of about 8 wt% gave the best thermal-fatigue life. The conventional alloy specification is for 18.5% cobalt, and hence, a factor of 2 in savings of cobalt could be achieved by using the modified alloy. After 13500 cycles, all bare cobalt-modified alloys lost 10 to 13 percent of their initial weight. Application of the NiCrAlY overlay coating resulted in weight losses of 1/20 to 1/100 of that of the corresponding bare alloy.

6832 **(PB—86-247574/XAB) Transient losses in superconductors. Final report, 1 October 1982-30 September 1985.** Goldfarb, R.B. (National Bureau of Standards, Boulder, CO (USA). Electromagnetic Technology Div.). Jun 1986. 63p. (NBSIR—86/3053). NTIS, PC A04/MF A01.

This report deals with hysteresis losses at 4°K measured by magnetization and complex magnetic susceptibility. The theoretical and experimental relationships between ac susceptibility and magnetization as functions of dc field were examined in terms of the critical-state model as developed by Carr and Clem. A theoretical method of calibrating ac susceptometers for cylindrical specimens, based on a mutual-inductance calculation, was developed.

6833 **(RFP-Trans—463) Process for electrolytic deposition of aluminum and beryllium from their nonaqueous solutions.** Takei, Tatsuko. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). Oct 1986. Contract AC04-76DP03533. Translated from Japanese Kokai Patent Disclosure No. Sho 55-158289 (1980). 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001642.

A process is described for electrolytic deposition of aluminum and beryllium from their nonaqueous solutions, wherein the electrolytic deposition is performed at current densities of 0.5 to 30 $A/dm^2$, the electrolytes used in the electrolysis bath are beryllium salts or aluminum salts selected from the group comprised by aluminum trifluoroacetate, beryllium trifluoroacetate, beryllium acetate and aluminum nitrate, the solvents used in the electrolysis bath are organic solvents selected from the group comprised by methanol, ethanol, isopropanol, acetonitrile, formaldehyde and ethylene glycol, a metal plate to be coated by electrolytic deposition is used as the cathode, and an aluminum plate or a platinum plate is used as the anode in the electrolytic deposition of aluminum or a beryllium plate or a platinum plate is used as the anode in the electrolytic deposition of beryllium. One or a mixture of two or more compounds selected from the group comprised by sodium or potassium perchlorate, trifluoroacetic acid, anhydrous trifluoroacetic acid, sodium or potassium trifluoroacetate, lithium chloride, boric acid, sodium or potassium borate, methyl or ethyl borate, citric acid, and sodium or potassium citrate is used as additives in the electrolysis bath. Aluminum powder and vinyl acetate are used as additives in the electrolysis bath for aluminum. Sodium or potassium sulfate is used as an additive in the electrolysis bath for beryllium. 3 tabs.

6834 **Surface finish measurements of diamond-turned electroless-nickel-plated mirrors.** Taylor, J.S.; Syn, C.K.; Saito, T.T.; Donaldson, R.R. (Lawrence Livermore National Lab., P.O. Box 808, Livermore, CA 94550). *Optical Engineering:* 25: No. 9, 1013-1020(Sep 1986). Contract W-7405-ENG-48.

Surface roughness data are presented for a matrix of diamond-turned electroless nickel samples having a combination of six phosphorus contents and four heat treatments. Roughness measurements were conducted with commercial optical and stylus profilers

(WYKO and Talystep). The results are discussed in terms of the material composition and heat treatment, plus other factors having an observed influence on the surface roughness. For the optimum material properties, full-length (665μm) 20x WYKO scans yielded values of better than 10 A rms after correction for instrument roll-off.

6835 **Quantitative energy-dispersive x-ray analyses of γ precipitates in an Al - 4.2 at% Ag alloy.** Howe, J.M.; Gronsky, R. (Dept. of Metallurgical Engineering and Materials Science, Carnegie-Mellon Univ., Pittsburgh, PA 15213). *Scripta Metallurgica;* **20**: No. 8, 1165-1168(Aug 1986).

The investigation was performed in order to determine whether the metastable γ′ precipitates have the composition given by the equilibrium phase diagram and if their composition varies with time. Energy dispersive x-ray spectroscopy (EDS) was used for the chemical analysis, in order to obtain accurate precipitate compositions without problems arising from fluorescence from surrounding Al matrix, the γ′ precipitates were extracted from an Al - 4.2 at% Ag alloy after aging for various times at 350°C. The 350°C aging temperatures was chosen because it is above the G.P. zone solvus for this alloy (Fig. 1), and the γ′ precipitates could be produced directly from the supersaturated solid solution without the influence of a prior G.P. zone distribution.

6836 **The acoustic emission measurement of cleavage initiation near the ductile brittle transition temperature in steel.** Lee, C.S.; Livne, T.; Gerberich, W.W. (Dept. of Chemical Engineering and Materials Science, Univ. of Minnesota, Minneapolis, MN 55455). *Scripta Metallurgica;* **20**: No. 8, 1137-1140(Aug 1986).

By use of the AE technique, the microcleavage fracture process in HSLA steel has been studied near the ductile-brittle transition temperature. Upon loading, several AE events were detected before final instability. Multiple origins of the cleavage were evident ahead of the fatigue crack front. It was concluded that weakest link hypotheses were not applicable near the ductile-brittle transition temperature. Good correlations were found between AE data and cleavage facets as a function of stress intensity factor.

6837 **Concerning the structure of a high pressure phase in californium metal.** Roof, R.B. (Los Alamos National Lab., NM, USA. Chemistry Div.). *Journal of the Less-Common Metals;* **120**: No. 2, 345-349(15 Jun 1986).

Using a model based on a hexagonal lattice and on a structure reported for the high pressure distorted f.c.c. phase of praseodymium a structure has been suggested for one of the high pressure phases of californium metal that is labeled 'distorted f.c.c.'. In the present work an alternative solution based on a triclinic cell is described. The application of either structure model to the reported d spacings of the high pressure phase of californium under consideration is discussed.

6838 **Comparison of the effects of deuterium and of hydrogen on the low temperature strength and ductility of vanadium.** Spitzig, W.A.; Owen, C.V. (Ames Lab., IA, USA. Dept. of Energy). *Journal of the Less-Common Metals;* **120**: No. 2, 301-305(15 Jun 1986).

The effects of equivalent amounts of deuterium and hydrogen on the strength and ductility of vanadium have been investigated for temperatures from 295 to 78 K. The results show that deuterium is a more potent strengthener in vanadium than hydrogen and that the strengthening in both V-D and V-H alloys occurs by a thermally activated process. Both deuterium and hydrogen cause a ductile-brittle transition behavior in vanadium, but the ductile-brittle transition temperature is higher in the V-D alloy.

6839 **Metal alloy film deposition by laser breakdown chemical vapor deposition.** Jervis, T.R. (Los Alamos National Lab., Materials Science & Technology Div., Los Alamos, NM 87545). pp 146 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Gas phase laser techniques for chemical vapor deposition (CVD) provide the advantages of low substrate temperature, cold walls, and limited reaction volume to the manifest advantages of good step coverage and low resistivity of thermal CVD metallizations. Using a pulsed CO/sub 2/ laser operating at 10.6μm, where there is no significant resonant absorption in any of the source gases, we succeeded in depositing elemental and alloy films from a number of gas phase precursors. Metastable phases can be formed in the deposited film if the surface energy of the deposited species is insufficient for rearrangement to the equilibrium crystalline phase. Using this technique, the authors have formed metastable crystalline compounds in thin-film structures. The present work involves the deposition of metal alloys of molybdenum and nickel. The Mo-Ni alloy system is known to form metastable amorphous alloys over a fairly broad range of alloy compositions, and these have been proposed as diffusion barrier metallizations.

6840 **Observations on the shock-synthesis of intermetallic compounds.** Horie, Y.; Graham, R.A.; Simonsen, I.K. (Sandia National Labs., Albuquerque, NM). pp 1023-1036 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC04-76DP00789.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

Recent studies of the chemical reactions under high pressure shock loading involved exothermic binary metallic systems, Ni-Aiota and Ti-Aiota. These studies have shown a complex array of simultaneous processes occurring prior to and during the shock pulse induced chemical reactions. This paper examines selected events thought to be important in the shock compression synthesis as shown by optical micrographs in conjunction with x-ray diffraction and electron probe microanalysis. The emphasis in this paper is placed on highlighting mechanisms that are influenced by material properties and configuration.

6841 **Dynamic consolidation of rapidly solidified type 304 SS powders.** Korth, G.E.; Flinn, J.E.; Green, R.C. (Idaho National Engineering Lab., EG & G Idaho, Inc., Idaho Falls, ID). pp 129-148 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC07-76ID01570.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

Rapidly solidified Type 304 stainless steel powders produced by two processes (centrifugal atomization and dissolved gas atomization) were consolidated by stress waves generated by high explosives. The metallurgical characteristics of the powder before and after consolidation are described which include examinations by optical and electron microscopy and microhardness. Particular attention is paid to the differences between the parameters to produce near full density "green" compacts and metallurgically fused monoliths. The evolution of the die/target design to produce fully dense, crack-free monoliths is illustrated and pressure-time history as calculated from a two dimensional hydrodynamic code is presented.

6842 **Calculation of thermal trapping in shear bands.** Swegle, J.W.; Grady, D.E. (Computational Physics and Mechanics Div. 1531, Thermomechanical and Physical Div. 1534, Sandia National Labs., Albuquerque, NM). pp 705-722 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC04-76DP00789.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

The microstructure associated with heterogeneous shear deformation observed in shock-loaded materials implies the possibility of transient local temperatures which far exceed those expected under homogeneous deformation. The possible consequences of

high local temperatures and resulting thermal softening are explored by using thermodynamic considerations to derive equations for the evolution of shear band temperatures. Inclusion of the equations in a finite-difference wavecode along with a previously developed model which accurately describes shockwave risetime behavior allows calculation of temperature states in the shock front. At low stresses, risetimes are long compared to thermal diffusion times and shear bands stay in thermal equilibrium with surrounding material, but at high stresses where risetimes are very short, shear band temperatures greatly exceed bulk temperatures before thermal equilibrium occurs. Decreasing yield strength with increasing shear band temperature followed by yield strength recovery as the shear bands cool produces an elastic precursor on reshock which cannot be obtained with standard elastic-plastic models. Good agreement is obtained with experimental data on aluminum. The calculations thus lend some credence to physical ideas of thermal trapping in shear bands.

6843 **Dynamic shock studies of vanadium.** Chhabildas, L.C.; Hills, C.R. (Sandia National Labs., Albuquerque, NM). pp 429-450 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC04-76DP00789.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

Using gas-gun loading techniques and velocity interferometric techniques, time-resolved wave profiles have been obtained in vanadium over the stress range of 2.9 to 9.7 GPa. These experiments are unique for this material, since there are no Hugoniot measurements available for vanadium below 20.0 GPa. As expected, the risetime data indicate steepened shock structures with increasing shock amplitude. However, unlike aluminum, finite risetimes are determined even at 9.7 GPa, indicating a large effective viscosity for the material. The dynamic yield strength measured at the Hugoniot elastic limit is 0.8 GPa and is approximately twice the static yield strength. Material softening is evidenced through measurements of shock velocity and yield strength determinations in the shocked state.

6844 **Influence of effective rate sensitivity on adiabatic shear instability.** Burns, T.J. (Computational Physics and Mechanics Div. I, Sandia National Labs., Albuquerque, NM). pp 741-748 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC04-76DP00789.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

An analysis is presented of the stability of dynamic simple shear in a ductile metal whose yield behavior is described by a mechanical flow rule, i.e., a material whose flow stress depends only on the instantaneous values of strain, strain rate, and temperature. It is shown that near the yield point, a region which usually has been ignored in shear stability studies, the steepness of the slope of the stress vs. strain curve of the material can be large enough for inertial effects to dominate over viscous effects for a short time, so that the process effectively has a rate sensitivity at early time which is smaller than the coefficient of rate sensitivity typically measured during an experiment. This combination of inertial effects and smaller viscous effects can be sufficient to cause only the longer-wavelength components of a perturbation on simple shear to retain much energy after a small amount of plastic flow, and thus it provides an explanation for the apparent growth of only longer-wavelength modes once the material begins to soften due to adiabatic heating and becomes unstable. The conclusions of this work should also apply to other materials testing experiments, such as the loading of bars in tension.

6845 **The Sandia computerized shock compression bibliographical database.** Wilbeck, J.S.; Anderson, C.E.; Hokanson, J.C.; Asay, J.R.; Grady, D.E.; Graham, R.A.; Kipp, M.E. (Sandia National Labs., Albuquerque, NM). pp 357-368 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC04-76DP00789.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

A searchable and updateable bibliographical database is being developed which will be designed, controlled, and evaluated by working technical experts in the field of shock-compression science. It will emphasize shock-compression properties in the stress region of a few tens of GPa and provide a broad and complete base of bibliographical information on the shock-compression behavior of materials. Through the operation of technical advisors, the database provides authoritative bibliographical and keyword data for use by both the inexperienced and expert user. In its current form, it consists of: (1) a library of journal articles, reports, books, and symposia papers in the areas of shock physics and shock mechanics, and (2) a computerized database system containing complete bibliographical information, exhaustive keyword descriptions, and author abstracts for each of the documents in the database library.

6846 **Steady-wave risetime and spall measurements on uranium (3-15 GPa).** Grady, D.E. (Thermomechanical and Physical Div., Sandia National Labs., Albuquerque, NM). pp 763-780 of Metallurgical applications of shock wave and high strain rate phenomena. Murr, L.E.; Staudhammer, K.P.; Meyers, M.A. New York, NY; Marcel Dekker Inc. (1986). (CONF-850770—). Contract AC04-76DP00789.

From EXPLOMET '85 - international conference on metallurgical applications of shock wave and high strain-rate phenomena; Portland, OR, USA (28 Jul 1985).

Planar impact experiments using thin discs of z-cut crystalline sapphire as impactors on samples of unalloyed uranium (D-38) have been performed over the pressure range of elastic response of the sapphire. The time-resolved motion of the uranium back free surface, due to the emerging shock wave, was monitored with laser velocity interferometry (VISAR). The propagation distance in most of the tests was sufficient to achieve a steady-wave plastic shock, and fast sweeping oscilloscopes were focused strictly on the rapidly-rising plastic wave. Impactor and sample thicknesses were selected to achieve spall within the uranium, and the spall signals were also measured. Risetime measurements indicate that the maximum strain rate in the plastic shock wave increases with the Hugoniot pressure, tending to a fourth power dependence at higher amplitudes, consistent with similar measurements on other metals. The spall strength determined from the pull-back signal ranges from 2.6 to 3.3 GPa and increases with increasing shock amplitude. Magnitude and rate dependence of the latter are consistent with a prediction of spall strength based on the material fracture toughness.

6847 **Electrochemistry of stress corrosion cracking of brass.** Seleet, M.M. Ames, IA; Iowa State Univ. (1986). 172p. University Microfilms Order No. 86-15,086.

Thesis (Ph. D.).

Stress corrosion cracking (SCC) susceptibility of pure copper and two brass (copper-zinc alloy) compositions (80/20 and 60/39) was studied in several ammoniacal and nonammoniacal aqueous solutions at open circuit potential, applying a constant load technique. The SCC tests, using tensile stress and loop specimens, showed pure copper to be immune in all solutions tested, the αB'-brass (60/39) alloy to be most susceptible to SCC, and the (80/20) alloy to have intermediate SCC susceptibility. The electrochemical tests (corrosion potential and Tafel plots) were utilized to prove the validity of the dissolution mechanism for the SCC propagation in solution with intermediate corrosion rates ($\sim 0.1 < I/sub\ cor/ < \sim 5$ mA/cm$^2$). The electrochemical tests were also used to predict the preferential dissolution of zinc (dezincification) in noncomplexing solutions, and the higher dissolution of copper (than that of zinc) in complexing solutions. The formation of intermediate cuprous complexes was detected using a rotating ring disc electrode (RRDE) composed of a brass (80/20) disc and platinum ring, in

ammonium chloride-cupric chloride solution. At very low corrosion rates, the stress corrosion cracking (is present) is assumed to operate by the brittle mechanical fracture mechanism in solution where ammonium ions ($NH_4^+$) can be generated.

6848 **Dynamic consolidation of aluminum powders.** Flinn, J.E.; Green, R.C.; Korth, G.E.; Wright, R.N. (Idaho National Engineering Lab., Eg&g Idaho Inc., Idaho Falls, ID). pp 713-718 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

One of the near-term objectives for dynamic consolidation of rapid solidification processing (RSP) powders at the Idaho National Engineering Laboratory is to produce fully dense, bonded and crack-free monoliths of suitable size for structure/property correlations. This has been realized for RSP Type 304 SS powders and the dynamic consolidation techniques are being applied to other RSP alloy systems. The dynamic consolidation behavior of powders of commercially pure aluminum and a dispersion strengthening aluminum alloy is reported in this paper.

6849 **Dynamic compaction of a monosized spherical tungsten powder.** Gourdin, W.H.; Weinland, S.L. (Lawrence Livermore National Lab., Livermore, CA). pp 725-730 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

We present a limited number of measurements of the Hugoniot of a 45-74-mum spherical tungsten powder in the stress range 0 to 7 GPa. From these data we infer that compaction to the solid density occurs at about 4 GPa. Examination of recovered specimens shows that interparticle bonding does not occur at stresses as high as 6.2 GPa. This is consistent with calculations based on the energy flux at powder particle surfaces during compaction, which suggest that interparticle melting will not occur at stresses less than about 9.0 GPa.

6850 **Shock consolidation of IN-100 nickel-base superalloy powder.** Wang, S.L.; Graham, R.A.; Meyers, M.A. (New Mexico Institute of Mining, Socorro, NM). pp 731-736 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Experiments were conducted to establish the stress, stress duration, and temperature conditions required for consolidation of a nickel-base superalloy. In order to accomplish this, the fixtures developed by Graham, Webb, and Davison, at Sandia National Laboratories were used. These fixtures were developed to produce quantitative, reproduceable experiments with well-characterized stress and temperature histories, determined by extensive studies with a two-dimensional code. The shock consolidation fixtures used are listed and the stresses and stress durations vary throughout the capsules and the range is shown. The average stress and stress duration can be considered as figures of merit, for comparison purposes between the various fixtures. It can be seen that both the pressure and stress duration were varied in the present experiments. The powders were kept under an argon atmosphere prior, during, and immediately following the experiments.

6851 **Mach stem characterization in MBAR designs using RSR powder.** Staudhammer, K.P.; Johnson, K.A. (Los Alamos National Lab., Los Alamos, NM). pp 737-742 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper examines the fortuitous aspects of the cylindrical explosion design, i.e., its suitability as a screening tool with its very high success rate of recovery. The designs allow the experimenter in one shot to observe a wide variety of pressure and strain variables. The effectiveness of this technique is shown using solid specimens of 304 stainless steel. The effect on powder studies is complex, and it is shown that the Mach stem melt zone size and location is a function of several additional variables. The unique microstructure of the Rapid Solidification Rate (RSR) powder was chosen to help characterize and delineate the effects. The powder was selected to help in the modeling of the formation of the Mach stem zone and this technique is not particularly used or recommended to compact RSR powder. The conditions explored here are in excess of those normally used to compact metallic powders.

6852 **Shock synthesis of nickel aluminides.** Simonsen, I.K.; Graham, R.A.; Horie, Y. (North Carolina State Univ., NC). pp 743-748 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper presents the results of further investigation of the observed synthesis of nickel aluminides in a mixture of elemental aluminum and nickel powders under high pressure shock wave loading. Localized formation of solid solutions of NiAl were observed in a specimen subjected to the weakest loading conditions (peak pressure of 5.0 GPa and peak temperature of 250 C). This is an indication of greatly enhanced solid state reactivity encountered under shock wave loading. The formation of bulk $Ni_3Al$ appears to require a temperature of about 400 C, but the reactions are inhibited by high pressures (above 15 GPa).

6853 **Shock-wave synthesis of titanium aluminides.** Horie, Y.; Graham, R.A.; Hoy, D.E.P.; Morosin, B.; Simonsen, I. (North Carolina State Univ., NC). pp 749-754 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

In an effort to gain improved insight into shock-induced chemical reactions in solids, the authors present the post-shock analysis of compound formation in an elemental titanium-aluminum powder mixture subject to a wide range of explosive shock-wave loading conditions. A process is described that involves blending of elemental powders, mechanical pressing to form compacts, vacuum sintering at temperatures in excess of 1200 C, and finishing steps chich include hot-isostatic pressing and final machining. Shock-wave processing contains steps which are to some degree similar to the above described elemental powder process, but the material states achieved in shock synthesis at very high pressures and high rates of loading are not accessible by any other process.

6854 **TEM of nickel aluminides produced by shock compaction.** Myers, S.A.; Graham, R.A.; Horie, Y.; Koch, C.G. (North Carolina State Univ., Raleigh, NC). pp 755-759 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

The authors produced nickel aluminides by high pressure shock loading. K-ray diffraction and electron microprobe microanalysis show large regions of the intermediate phase $Ni_3Al$ resulting from chemical synthesis of the elemental nickel and aluminum powders. Microhardness tests of this $Ni_3Al$ show mechanical properties similar to $Ni_3Al$ alloys prepared by rapid solidification techniques. To understand the structure/property relationships, transmission electron microscopy was used to analyze the $Ni_3Al$ regions in two samples fabricated by different explosives, mean pressures and bulk temperatures. Increasing pressure and resulting peak temperatures give rise to a much finer grain size of less than 5 nm with a corresponding increase in hardness. No antiphase boundaries were seen as is common in rapidly solidified material and very little defect damage was seen as is common in shock loaded samples.

6855 **Synthesis of nickel-aluminum alloys by shock compression of composite particles.** Pak, H.R.; Graham, R.A.; Horie, Y. (Institute of Mining and Technology, Socorro, NM). pp 761-766 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

We report electron microscope observations of compound formation in Ni/Al composite powders by shock loading. Reactions with substantial yield are seen in outer areas of a recovered specimen, while unreacted or locally reacted regions are seen in the center and middle areas of the specimens. $Ni_3Al$ is formed in a gamma solid-solution of Ni. The microstructure is very complex.

6856 **Optical measurements of shock-induced chemical reactions in mixed aluminum-nickel powder.** Boslough, M.B.; Graham, R.A.; Webb, D.M. (Sandia National Labs., Albuquerque, NM). pp 767-772 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Optical pyrometer and high-speed photography experiments have been carried out to determine the temperature and temporal-spatial evolution of a chemical reaction zone in shock-loaded, nickel-aluminum powder mixtures. The temperature generated is about 5000 K, and the reaction occurs on a 100 nanosecond or faster time scale. Experimental results are compared to numerical calculations, which suggest that there are threshold shock pressures and temperatures of about 15 GPa and 500 degrees C which are required to initiate the strong exothermic reaction. Further, excessive pressure appears to inhibit reaction. This observation is in agreement with previous experiments in which nickel-aluminum alloys were recovered from shock-loaded mixtures.

6857 **Shock-induced temperature distributions in powder compact recovery fixtures.** Graham, R.A.; Webb, D.M. (Sandia National Labs., Albuquerque, NM). pp 831-836 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Sandia "Bear" and "Bertha" powder compact recovery fixture systems for explosive loading have been widely used to preserve powder compact samples for post-shock analysis. Shock conditions within the compacts are determined from an extensive program of numerical simulation which reveals that, even though the initial loading is planar, the sample conditions are controlled by a radial-mode compression. The wavetrapping phenomenon which occurs in the powder samples leads to relatively uniform shock-induced temperatures except for a very hot area in the outer edge region of some fixtures.

6858 **Velocity measurements of laser-driven flyers backed by high impedance windows.** Sheffield, S.A.; Castaneda, J.N.; Rogers, J.W. (Sandia National Lab., Albuquerque, NM). pp 541-546 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper characterizes the response of free standing and backed foils to lower laser intensity levels, i.e., in the region of 1-20 $GW/cm^2$, and using these flyers to initiate insensitive secondary high explosives. In this study the output of a 3.5-J Nd:glass laser with a 16 ns pulse was used to drive 1.5-mm-diameter aluminum flyers. Water, fused silica, and sapphire were investigated as backing materials for the flyers. A 66-um-thick, tamped Al foil can be accelerated to a velocity greater than 2.5 km/s and about 20 percent of the Al is ablated during the acceleration process. Under these conditions, the efficiency of coupling laser energy into flyer kinetic energy is about 25%. Upon impact, this flyer can detonate high-density, insensitive, secondary explosives. To accelerate free-standing foils for this purpose, the laser fluence would need to be greatly increased.

6859 **Numerical simulation of a sample recovery fixture for high velocity impact.** Norwood, F.R.; Graham, R.A.; Sawaoka, A. (Sandia National Labs., Albuquerque, NM). pp 837-842 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Numerical simulations of shock compression conditions in the Tokyo Institute of Technology sample recovery fixture for high velocity impact have been carried out with two-dimensional (CSQ) and three-dimensional (HULL) computer codes. For the impact of stainless steel on the stainless steel capsule at a velocity of 2.5 km/sec, it is found that two-dimensional effects within the low density powder samples dominate the loading process and that interactions between the four samples are negligible. Because of the much higher pressure encountered, the two-dimensional effects are qualitatively different than those found for the Sandia "Bear" explosive fixtures.

6860 **Properties of niobium recovered from megabar dynamic pressures.** Nellis, W.J.; Dalder, E.N.; Maple, M.B.; McElfresh, M.; Mitchell, A.C.; Moss, W.C.; Radousky, H.B.; Summers, L.T. (Lawrence Livermore National Lab., Livermore, CA). pp 719-724 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Nb was processed and recovered intact from peak dynamic pressures in the range 0.6-1.2 Mbar. Pressure and effective-plastic-strain histories were calculated using a finite-element hydrodynamic computer code. Recovered specimens were characterized by X-ray diffraction, metallography, Vicker's hardness, and superconducting transition temperature T /SUB c/ . The maximum change observed in the T /SUB c/ of 9.18 k for the unshocked specimen was a decrease of 0.035 K in the specimen shocked to a maximum pressure of 0.6 Mbar. Shock processing of $V_3Si$ at 1 Mbar was recently reported by Stewart et al. to depress T /SUB c/ 1.8 K from the initial value of 16.4 K. These results indicate that shock-induced defects and disorder have a relatively weak effect on the T /SUB c/ of equilibrium phases and suggest that shock-synthesized metastable superconductors might have T /SUB c/ 's close to intrinsic values for the ordered material.

6861 **(BLL-M—6738-(5828.4)) Connection of high-temperature strength and structural state of steel 12KhlMF with parameters of signals of acoustic emission under tension.** Smirnov, A.N.; Chelyshev, N.A. Translated from *Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya ;* No. 10, 156-157(1985). 4p. British Library Lending Div., Boston Spa, England.

An express method for estimation of long-term strength from the parameters of signals of acoustic emission under tension was investigated on heat-resistant pearlitic chromium-molybdenum-vanadium steel 12Kh1MF. A connection was established between the nature of signals of acoustic emission in 12Kh1MF and the structural state of the steel.

## 3602 Ceramics, Cermets, And Refractories

*REFER ALSO TO CITATION(S) 6673, 6715, 6715, 7360*

6862 **(AD-A—171554/9/XAB) $VO_2$ thin films. Interim report, August 1985-July 1986.** Hui, Y.; Brusasco, R.; Kershaw, R.; Dwight, K.; Wold. (Brown Univ., Providence, RI (USA). Dept. of Chemistry). Jul 1986. 12p. NTIS, PC A02/MF A01.

Amorphous films of vanadium dioxide were prepared by the thermal decomposition of vanadium acetylacetonate in a $CO/CO_2$ atmosphere. Films were deposited on glass and quartz.

**6863 (AD-A—171816/2/XAB) Expansion coefficient on oxides and oxide ceramics. Final report, December 1984-June 1985.** Covino. (Naval Weapons Center, China Lake, CA (USA)). May 1986. 44p. (NWC-TP—6663). NTIS, PC A03/MF A01.

Expansion coefficients for existing oxides and oxide ceramics were compiled. In some cases, where data are available, a description of how the thermal expansion coefficient was measured is noted.

**6864 (CEA-R—5342) Study of the stability of ordered phases in non-stoichiometric transition metal carbides and nitrides.** Landesman, J.P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Mar 1986. 184p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE87750222.

After presenting the results of neutron diffraction experiments on the ordered compounds $Nb_8C_5$ and $Ti_2N$, we propose a classification of the ordered phases encountered in this class of compounds, and, using a tight-binding description of the electronic structure, we calculate the band energy for several ordered configurations and the disordered configuration, for a given metalloid vacancy concentration. We can then, on one hand, predict the relative stability (at O K) of the various ordered phases possible at this concentration - and these predictions are in good agreement with the experimental observations, mainly in the case of carbides - and on the other hand calculate the effective pair interactions $V_1$ and $V_2$ which appear in the Ising model and reconstruct theoretical stability maps, for any vacancy concentration, which are again in agreement with the phenomenological stability maps (overall agreement in the case of nitrides, more precise agreement in the case of carbides).

**6865 (CONF-860714—5) Structure of high-angle grain boundaries in NiO.** Merkle, K.L.; Reddy, J.F.; Wiley, C.L.; Smith, D.J. (Argonne National Lab., IL (USA); Arizona State Univ., Tempe (USA)). 1986. Contract W-31-109-ENG-38. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001540.

From 22. University conference on ceramics - ceramic microstructures '86: role of interfaces; Berkeley, CA, USA (28 Jul 1986).

The atomic structures of <001> tilt grain boundaries (GB) in NiO have been studied by high-resolution electron microscopy (HREM). Bicrystalline specimens grown by the Verneuil technique were examined for a range of misorientation angles.

**6866 (N—86-29959) Structural characterization and gas reactions of small metal particles by high-resolution TEM and TED. Semiannual technical report, 1 January-30 June 1985.** Heinemann, K. (Eloret Corp., Sunnyvale, CA (USA)). Jun 1985. 49p. (NASA-CR—176949; NAS—1.26:176949). NTIS, PC A03/MF A01.

The interaction of 100 and 200 keV electron beams with amorphous alumina, titania, and aluminum nitride substrates and nanometer-size palladium particulate deposits was investigated for the two extreme cases of (1) large-area electron-beam flash-heating and (2) small-area high-intensity electron-beam irradiation. The former simulates a short-term heating effect with minimum electron irradiation exposure, the latter simulates high-dosage irradiation with minimum heating effect. All alumina and titania samples responded to the flash-heating treatment with significant recrystallization. However, the size, crystal structure, shape, and orientation of the grains depended on the type and thickness of the films and the thickness of the Pd deposit. High-dosage electron irradiation also readily crystallized the alumina substrate films but did not affect the titania films. The alumina recrystallization products were usually either all in the alpha phase, or they were a mixture of small grains in a number of low-temperature phases including gamma, delta, kappa, beta, theta-alumina. Palladium deposits reacted heavily with the alumina substrates during either treatment, but they were very little effected when supported on titania. Both treatments had the same, less prominent localized crystallization effect on aluminum nitride films.

**6867 (N—86-30818) Radiation data definitions and compilation for equipment qualification data bank.** Bouquet, F.L.; Winslow, J.W. (Jet Propulsion Lab., Pasadena, CA (USA)). 1986. 215p. (NASA-CR—176259; NAS—1.26:176259). NTIS, PC A10/MF A01.

Dose definitions, physical properties, mechanical properties, electrical properties, and particle definitions are listed for insulators and dielectrics, elastomeric seals and gaskets, lubricants, adhesives, and coatings.

**6868 Chemical and optical properties of electrochromic nickel oxide films.** Lampert, C.M.; Omstead, T.R.; Yu, P.C. (Lawrence Berkeley Lab., CA, USA). *Solar Energy Materials;* **14**: No. 3-5, 161-174(Nov 1986). (CONF-850887—). Contract AC03-76SF00098.

From SPIE international technical symposium on optical and electro-optical engineers; San Diego, CA, USA (18 Aug 1985).

Thin films of nickel oxide-nickel hydroxide are investigated to determine electrochromic switching properties. Crystalline nickel oxide films are synthesized by electrochemical deposition and by anodization of nickel electrodes. Electrochemical deposition using nickel sulfate-based chemistry is used to deposit films directly on doped tin oxide-coated glass. Spectral solar transmittance is obtained for films switched in liquid cells containing a KOH electrolyte. The solar transmittance (Ts) can be switched from Ts(bleached) = 0.73 to Ts(colored) = 0.35 for films with a thickness of about 500 A. Voltammetric data is correlated to known electrochemical processes for nickel electrodes. The nickel oxide films are chemically analyzed using a sputter-Auger microprobe and X-ray photoelectron spectroscopy. As a result of combined analysis, it was determined that these films transform from uncolored to colored states by the reversible transformation of nickel hydroxide, Ni(OH)/sub 2/, to nickel oxyhydroxide, NiOOH, and that dehydrated films correspond chemically to NiO. 10 figs., 24 refs., 1 tab.

**6869 Doped vanadium oxide for optical switching films.** Jorgenson, G.V.; Lee, J.C. (Honeywell Systems and Research Center, Minneapolis, MN, USA). *Solar Energy Materials;* **14**: No. 3-5, 205-214(Nov 1986). (CONF-850887—).

From SPIE international technical symposium on optical and electro-optical engineers; San Diego, CA, USA (18 Aug 1985).

An ion-beam-sputtering system is used to deposit doped vanadium dioxide (V/sub 1-x/M/sub x/O/sub 2/), where M is a dopant that decreases the transition temperature (Tt) from that of stoichiometric VO/sub 2/. The objective is to synthesize a material that will passively switch between a heat-transmitting and a heat-reflecting state at specific design temperatures. The technique is reactive ion beam sputtering of vanadium and a dopant in a well controlled atmosphere of Ar with a partial pressure of O/sub 2/. The films are deposited at elevated temperature (> 750 K) onto glass and sapphire substrates for spectrophotometric evaluation above and below the transition temperature. The longer range goals of this research are to develop the material for: thin film application to building glazings, and pigments for opaque wall coatings. The glazings will transmit and the walls will absorb solar energy when the V/sub 1-x/M/sub x/O/sub 2/ temperature (T) is low (T < Tt). At T > Tt, both glazings and walls will reflect the solar infrared. 9 figs., 8 refs., 2 tabs.

**6870 Chemical synthesis under high pressure shock loading.** Graham, R.A.; Boslough, M.; Carr, M.J.; Horie, Y.; Morosin, B.; Venturini, E.L.; Williamson, D.L. (Sandia National Lab., Albuquerque, NM). pp 693-711 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper discusses the current status of studies in shock-induced solid state chemistry. Two systems are found to provide a basis for studying controlled chemical synthesis. Intermetallic alloys

have been found to be produced in a controlled manner from mechanical mixtures of aluminum with either nickel or titanium. Optical measurements show that a strong chemical reaction is induced on a 1-0 nanosecond time scale in such aluminum-nickel mixtures under shock compression. The nonferrous metal oxide-ferric oxide system is another promising chemical system in which mixtures of zinc oxide and ferric oxide readily form a zinc-deficient zinc ferrite. Shock-induced chemical synthesis appears to provide a significant opportunity for the synthesis of new materials. The study of chemical effects associated with shock loading provides a new probe of shock-compression processes and current descriptions of the conditions under which they can occur suggest that chemical effects may be ubiquitous in fully dense materials encountered in shock compression studies.

6871 **Dynamic compaction of SiC powder.** Akashi, T.; Beauchamp, E.K.; Lotrich, V.; Sawaoka, A. (New Mexico Institute of Mining and Tech., Socorro, NM). pp 779-784 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper studies the compaction mechanism of coarse SiC powder in the dynamic compaction process, which may be different from that of the fine powder. The relative densities of the compacts were measured by a water displacement method. The microstructures of the compacts were examined using scanning electron microscopy. The crystallite size and the lattice strain of the SiC compacts are shown. In dynamic compaction, powder compacts of coarse SiC powder can be densified to near solid density at the shock wave front and consolidated to a strongly bonded compact by melting and subsequent solidification of material during and after shock-compression processes.

6872 **X-ray diffraction studies of shock-synthesized zinc ferrite.** Morosin, B.; Graham, R.A.; Venturini, E.L. (Sandia National Labs., Albuquerque, NM). pp 797-801 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Mechanically-blended stoichiometric powder mixtures of zinc oxide and ferric oxide have been subjected to high pressure shock wave loading between 7.5 and 27 GPa. By varying the initial packing densities between 2.15 and 3.38 $Mg/m^3$ in recovery fixtures, peak shock temperatures between 125 and 1,100 degrees C were achieved. X-ray diffraction shows formation of a spinel structure type. The amount depends on shock parameters; unequal consumption of initial oxides suggests a defective spinel Zn /SUB 1-x/ FE /SUB x/ $Fe_2O_4$ rather than stoichiometric $ZnFe_2O_4$ is formed. A comparison is made between materials prepared by shock loading and by furnace firing.

6873 **Analytical electron microscopy study of shock synthesized zinc ferrite.** Graham, R.A.; Carr, M.J. (Sandia National labs., Albuquerque, NM). pp 803-808 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Mixtures of zinc oxide and hematite were shock loaded to various conditions, some of which resulted in the formation of zinc ferrite. Selected samples of reacted and unreacted mixtures were examined for the presence of zinc ferrite. Shock synthesized ferrite, having the spinel crystal structure, was found to occur as recrystallized regions within a heavily deformed matrix of well mixed reactants. The synthesized ferrite was not stoichiometric, but rather was found to be Zn /SUB 1-x/ Fe /SUB 2+x/ $0_4$, where x=0.09+/-0.02.

6874 **Moessbauer study of shock-synthesized zinc ferrite.** Williamson, D.L.; Graham, R.A.; Morosin, B.; Venturini, E.L. (Colorado School of Mines, Golden, CO). pp 809-814 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Mossbauer spectroscopy has been used to characterize ZnO-$Fe_2O_3$ powder mixtures subjected to shock loading at 22 GPa with associated peak shock temperatures ranging from 300 degrees C to 655 degrees C. The $^{57}Fe$ spectra for the shock-synthesized zinc ferrite yield similar values for the isomer shift, quadrupole splitting and magnetic hyperfine field suggesting that the same composition is produced over a wide range of shock conditions. A comparison is made to furnace-reacted material prepared from the same powder mixture.

6875 **Shock-recovery experiments on PZT 95/5.** Chhabildas, L.C.; Carr, M.J.; Kunz, S.C.; Morosin, B. (Sandia National Labs., Albuquerque, NM). pp 785-790 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Recovery experiments on porous PZT 95/5 ferroelectric have been performed on a single-stage compressed gas gun over the stress range of 0.3 to 4.6 GPa. Density measurements on the recovered specimens suggest permanent pore compaction. X-ray diffraction analysis indicates that the shock-induced FE-to-AFE phase transformation is reversible, with a reduction in the residual lattice strain, as compared with the unshocked material. SEM and TEM microscopy show evidence of ferroelectric domains with fewer numbers at the higher stress. The microstructure of the 3.0 GPa sample is significantly affected, as evidenced by dislocation slip bands and oval-shaped voids.

6876 **The effect of shock compression on graphite-like boron nitride.** Akashi, T.; Graham, R.A.; Sawaoka, A. (New Mexico Institute of Mining and Technology, Socorro, NM). pp 821-825 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Well crystallized graphite-like boron nitride (g-BN) powder particles were shock treated at a nominal peak pressure of 27 GPa in the Sandia Baby Bear fixture. The microstructure of the recovered BN compacts was found to be sensitive to the powder densified mainly by particle fracture in the central region of the fixture and by plastic deformation in the outer region of the fixture.

6877 **Heterogenous response of aluminum and lithium niobate to shock waves.** Perry, F.C.; Noack, D. (Sandia National Lab., Albuquerque, NM). pp 655-660 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Heterogeneous shock effects were studied in aluminum (6061-T6) and single crystal lithium niobate (Z-cut) in the range 0.7-4.5 GPa by means of holographic interferometry. Heterogeneous yielding in lithium niobate was observed directly for the first time. In addition, nucleation or activation of defects were observed in both aluminum and lithium niobate. The single crystal data indicate that a defect-dominated fracture process constitutes a reasonable model for shock compression. The polycrystalline data suggest that a similar pattern will prevail at a sufficiently high pressure.

6878 **Magnetic properties of shock-synthesized and furnace-reacted zinc ferrite.** Venturini, E.L.; Graham, R.A.; Morosin, B. (Sandia National Labs., Albuquerque, NM). pp 815-820 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

The static magnetic properties of spinel structure zinc ferrite are compared for products from shock synthesis and conventional isothermal reaction using a stoichiometric mixture of zinc oxide and ferric oxide powders. The high-pressure shock-wave loading produces a ferrimagnetic material with a substantial saturation magnetization, while the furnace reaction product is paramagnetic at room temperature. Since stoichiometric zinc ferrite is paramagnetic, these results indicate that a zinc-deficient ferrite is formed by shock processing in contrast to a nearly stoichiometric compound obtained by heating in air. X-ray diffraction data confirm that less zinc oxide is consumed than ferric oxide during shock loading.

6879 **(N—86-28997) Sintering and properties of $Si_3N_4$ with and without additives by HIP treatment.** Kuratani, S.; Shimada, M.; Koizumi, M. Translated from *Zairyo ;* 33: No. 374, 1372-1377(Nov 1984). 19p. (NASA-TM—88386; NAS—1.26:88386). NTIS, PC A02/MF A01.

Hot Isostatic Pressing (HIP) of $Si_3N_4$ powders with and without additives was performed using a glass container, and various kinds of pressureless-sintered $Si_3N_4$ were HIP'ed without a container. The effects of HIP treatment on density, microstructure, flexural strength, microhardness, and fracture toughness on $Si_3N_4$ ceramics were studied. Using a glass container it was difficult to reach theoretical density. The microhardness of HIP'ed $Si_3N_4$ without additives was low, and the fracture toughness of HIP'ed $Si_3N_4$ with and without additives was 22 to 25 W/m-K, and it decreased with increasing the amount of additives. The density and flexural strength, and hardness of pressureless-sintered $Si_3N_4$ which contained $Al_2O$ and $Y_2O_3$ as oxide additives were remarkably improved by HIP treatment using nitrogen as a pressure transmitting gas. It is very important to select the sintering conditions for fabricating the presintered body of $Si_3N_4$ in order to improve the mechanical properties of $Si_3N_4$ by HIP treatment.

## 3606 Other Materials

*REFER ALSO TO CITATION(S) 6494, 6495, 6572, 6749, 6805, 6807, 6807, 6807, 6867, 6953, 7201, 7243, 7503*

6880 **(AD-A—171743/8/XAB) Environmental effects on impact-damage tolerance of hybrid composite material. Final report.** Wood, L.E. (Naval Academy, Annapolis, MD). 28 May 1986. 56p. (USNA-TSPR—140). NTIS, PC A04/MF A01.

The behavior of an intraply hybrid composite material of polyethylene and graphite fibers in an epoxy matrix under the effects of environmental conditioning, impact damage, and fatigue loading was investigated. Although the ultimate tensile strength of the hybrid material was found to be lower than that of graphite material alone, the specific strengths of the materials were comparable. Dye-penetrant enhanced x-ray radiography and edge replication were used to evaluate the damage growth of the test material. Impact-damage evaluations showed the initial crack tolerance of the hybrid materials was better than that of conventional graphite. Specimens of both materials were soaked in standard ocean water and their moisture absorption observed. The moisture absorption percentages for the hybrid and graphite materials were 2.91% and 1.47% by weight, respectively. Both dry and wet hybrid material was subjected to impact and fatigue loading. During fatigue loading the hybrid material exhibited viscoelastic behavior characterized by a nonlinear loading curve. The wet hybrid material experienced both a sharper reduction in stiffness, and a greater increase in damage area than the dry material.

6881 **(AD-A—171798/2/XAB) Investigation of microstructural factors that cause low fracture toughness in silicon carbide whisker/Al alloy composites. Annual report, 1 May 1985-28 February 1986.** Wawner, F.E.; Harris, C.R. (Virginia Univ., Charlottesville (USA). Dept. of Materials Science). 15 Aug 1986. 38p. (UVA—525398/MS87/101). NTIS, PC A03/MF A01.

The problem of low fracture toughness and low elongation to failure in silicon carbide whisker/aluminum alloy matrix composites is controlled by matrix composition and microstructure. Large, brittle, constituent particles as well as other precipitate phases along whisker interfaces strongly influence these properties. The purpose of this study is to define the fracture characteristics of the material from an atomic standpoint; to define the factors that influence fracture toughness and elongation; to propose a model for the failure mechanism and steps that can be taken to enhance the properties; and to evaluate materials produced by using these concepts. Work during the first year of this program has emphasized microstructural and mechanical property evaluation of systems with altered chemistry of the alloy matrix and thermomechanical treatments of standard alloy systems.

6882 **(AD-A—171990/5/XAB) Characterization of mechanical-damage mechanisms in ceramic composite materials. Technical report, 24 May 1985-23 May 1986.** Lankford. (Southwest Research Inst., San Antonio, TX (USA)). Jul 1986. 75p. (SWRI—06-8124). NTIS, PC A04/MF A01.

Yielding behavior and deformation modes are characterized for single-crystal and polycrystalline yttria-stabilized $ZrO_2$ tested in compression from 23 to 800C. The plastic flow of single-crystal specimens is orientation- and temperature-dependent, and is interpreted in terms of TEM evidence of dislocation activity, and an hypothesized tetragonal-to-cubic transformation. Polycrystalline material deforms at intermediate temperatures (about 800C) by forming unstable shear bands, which flow via grain-boundary sliding and cavitation. Although both strength and ductility increase with strain rate, polycrystalline strength decreases rapidly with increasing temperature. Continuous SiC fiber-reinforced glass-matrix composites were tested in compression over a wide range in temperature and loading rate. Both uniaxial and crossplied fiber orientations were studied. Strength is found to depend sensitively on orientation and loading rate, while temperatures to 800C have less effect. Orientation effects are explained in terms of matrix microfracture and fiber buckling. The latter are shown to also control strengthening at very high(Hopkinson Pressure Bar) strain rates, where it is hypothesized that strength is enhanced by inertial effects that inhibit the development of the localized pockets of intense matrix microfracture and general buckling required for the nucleation of fiber kinks.

6883 **(BNL—38651) Theoretical reflectivities of some mosaic crystals for x-ray monochromatization.** Freund, A.K. (Brookhaven National Lab., Upton, NY (USA)). Aug 1986. Contract AC02-76CH00016. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002396.

Maximum peak reflectivities were estimated for several materials and mosaic spreads up to 30 minutes. The results show that whenever lower resolution and some increase of the beam size can be tolerated substantial gains in intensity are possible by replacing perfect crystal monochromators by mosaic crystals. In particular beryllium is highly efficient and pyrolytic graphite of better quality would be desirable.

6884 **(BNL—38773) Anisotropic spin fluctuations in the itinerant-electron ferromagnet MnP.** Yamada, K.; Todate, Y.; Endoh, Y.; Ishikawa, Y.; Boeni, P.; Shirane, G. (Brookhaven National Lab., Upton, NY (USA); Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science; Tohoku Univ., Sendai (Japan). Dept. of Physics). 1986. Contract AC02-76CH00016. 19p. (CONF-861111—12). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002148.

From Conference on magnetism and magnetic materials; Baltimore, MD, USA (17 Nov 1986).

The paramagnetic scattering cross section of the anisotropic metallic ferromagnet MnP has been measured up to the zone boundaries along the [100] and [010] directions perpendicular to the

easy magnetization axis. The spectral shape functions in both directions are well fitted to a Lorentzian form at T=T/sub c/ (290.5K), 1.03T/sub c/ and 1.20T/sub c/ except those close to the zone boundaries. Near T/sub c/ the line width along [010] follows the dynamical scaling prediction for the isotropic ferromagnet Γ (q) proportional to q/sup 2.5/. On the contrary, a unique q dependence, Γ (q) proportional to q/sup 3.2/ along [100] was observed. However these q dependences deviate at small q ($q < 0.1$ $A^{-1}$ along [100] and $q < 0.02$ $A^{-1}$ along [010]) suggesting the existence of a residual linewidth of $\Gamma'_0 \sim 0.02$ MeV at $q = 0$.

6885 **(CEA-CONF—8449) Corrosion rate of nuclear glass in saturated media.** Fillet, S.; Vernaz, E.; Nogues, J.L.; Jacquet-Francillon, N. (CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France)). May 1986. 21p. (CONF-860418—20). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750245.

From 88. annual meeting of the American Ceramic Society; Chicago, IL, USA (27 Apr 1986).

In a geological repository, the glass is leached by water with a complex composition resulting from alteration of all of the environmental materials. Equilibrium conditions are quickly attained, given the very low water renewal rate in the repository, especially near the glass surface protected by the engineered barrier. Glass solubility limit for $SiO_2$ is quickly reached, corrosion then progress only at the rate of Si ion transport by the water or by diffusion. An analysis of 15 long term static leaching experiments shows that while corrosion generally ceases in the absence of water circulation, this hypothesis cannot be postulated as a general law. These test results confirm the frequently reported fundamental importance of the silicon concentration on the glass corrosion rate. However, a simple approach in terms of a glass solubility limit for silica cannot account for the experimental findings. Although a relation of the type V = (Csub(sat) - Csub(Si))sup(n) is acceptable for a single experiment, it appears that the actual Csub(sat) value varies substantially from one experiment to another. If a Csub(sat) variation range can be defined, and if a medium can be selected in which the silicon concentration always exceeds this range, the corrosion process can probably be stopped.

6886 **(CEA-R—5343) Ferrimagnetic oxides: syntheses and radiation effects with GANIL heavy ions beams.** Fuchs, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI); Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). Mar 1986. 218p. (In French). NTIS (US Sales Only), PC A10/MF A01. File Number DE87750223.

Radiation effects with GANIL heavy ions beams in magnetic oxides ($BaFe_{12}O_{19}$, $Y_3Fe_5O_{12}$), well known for their industrial applications, have been investigated by magnetization measurements, Moessbauer spectrometry, and high resolution electron microscopy. Structural and magnetic order modifications induced by heavy ion bombardment can lead to amorphous material. Our experimental results have been explained on the basis of different amorphization processes, depending on incident ions (mass, energy) and the nature of the target. With 1.8 GeV argon ions, the evolution of the relative magnetization versus the number of displacements per atoms is the same for $BaFe_{12}O_{19}$ and $Y_3Fe_5O_{12}$. Amorphization process is closely related to atomic collisions. With 2.9 GeV krypton ions, nuclear stopping power can still explained the amorphization of $BaFe_{12}O_{19}$. On the other hand, electronic stopping power become great enough to create tracks in $Y_3Fe_5O_{12}$. With 3 GeV xenon ions, amorphization process is related to nuclear tracks created in $BeFe_{12}O_{19}$ and $Y_3Fe_5O_{12}$. Structural and magnetic order modifications induced by energetic heavy ions have been investigated in new antiferromagnetic oxides $Ba_2Sb_2M_3$-$Fe_8O_{22}$ (M=Ni, Co, Mg, Zn) which we have prepared and studied.

6887 **(CONF-861068—11) Effect of support morphology on composite membrane performance.** Taylor, E.J.; Pazienza, C.; Waterhouse, R.; Wilemski, G. (Physical Sciences, Inc., Andover, MA (USA)). Oct 1986. Contract FC07-84ID12495. 2p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001795.

From Electrochemical Society fall meeting; San Diego, CA, USA (19 Oct 1986).

Investigations are being conducted of the effect of microporous Teflon support structures on the characteristics of a supported membrane (impregnated with Nafion) in a chlor-alkali environment. Data are presented for the specific resistivity vs pore diameter and for membrane voltage drop vs current density. (DLC)

6888 **(ESA-SP—43) Proceedings of a workshop on composites design for space applications.** Burke, W.R. (European Space Agency, 75 - Paris (France)). Feb 1986. 375p. NTIS, PC A16/MF A01.

From Proceedings of a Workshop on Composites Design for Space Applications; Noordwijk, Netherlands (15 Oct 1985).

The choice and characteristics of composite materials for space applications, calculation and design methods, and dimensional stability were some areas of discussion in this workshop. Also discussed was integrity control, Ariane applications of composites, load carrying structures in satellites, and satellite antenna and solar array applications.

6889 **(LBL—22220) Observation of stoichiometry changes beneath metal contacts on GaAs.** Liliental-Weber, Z.; Weber, E.R.; Newman, N.; Spicer, W.E.; Gronsky, R.; Washburn, J. (Lawrence Berkeley Lab., CA (USA); California Univ., Berkeley (USA). Dept. of Materials Science and Mineral Engineering; Stanford Univ., CA (USA). Stanford Electronics Labs.). Aug 1986. Contract AC03-76SF00098. 6p. (CONF-860895—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001718.

From 14. international conference on defects in semiconductors; Paris, France (18 Aug 1986).

The structure of metal-semiconductor Schottky contacts (Au:GaAs, Al:GaAs, and $TiSi_2$:GaAs) was investigated by high-resolution and analytical electron microscopy. In all cases investigated, a change in stoichiometry (increase of the As/Ga ratio) in the GaAs beneath the metal contact was observed. This indicates the formation of anion-rich defects at Schottky contacts on GaAs, giving strong support for the defect models of Fermi level pinning.

6890 **(LBL—22260) TEM study of precipitates in as-grown semi-insulating indium-doped GaAs.** Lee, B.T.; Sands, T.; Gronsky, R.; Bourret, E. (Lawrence Berkeley Lab., CA (USA); Bell Communications Research, Inc., Red Bank, NJ (USA)). Sep 1986. Contract AC03-76SF00098. 16p. (CONF-8609150—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001892.

From International symposium on gallium arsenide and related compounds; Las Vegas, NV, USA (28 Sep 1986).

Precipitation in as-grown semi-insulating In-doped GaAs crystal has been studied using transmission electron microscopy. Hexagonal As precipitates that exhibit a very simple orientation relationship with the GaAs matrix were found, although the crystal showed no evidence of In-containing particles. Precipitates of quite different phase(s), very likely a new As-rich Ga-As phase, have also been observed with very large interplanar spacings. The number density of these particles is estimated to be approximately $1.5 \times 10^9$/$cm^3$.

6891 **(N—86-28195) Radiation effects on high performance polymers. Final technical report, 1 June 1985-28 February 1986.** Orwoll, R.A. (College of William and Mary, Williamsburg, VA (USA)). 1986. 10p. (NASA-CR—177191; NAS—1.26:177191). NTIS, PC A02/MF A01.

Polymer matrix materials are candidates for use in large space antennas and space platforms that may be deployed in geosynchronous orbit 22,500 miles above the Earth. A principal concern is the long term effects of an environment that is hostile to organic polymers, including high energy electromagnetic radiation, bombardment by charged particles, and large abrupt changes in temperature. Two polyarylene ethers which might be utilized as models for polymers in space applications were subjected to dosages of 70 keV electrons up to 3.4 x 10 to the 10th power rad. The irradiated films were then examined to determine the effects of the high-energy electrons.

**6892** **(N—86-28196) Effects of energetic proton bombardment on polymeric materials: experimental studies and degradation models.** Coulter, D.R.; Gupta, A.; Smith, M.V.; Fornes, R.E. (Jet Propulsion Lab., Pasadena, CA (USA)). Jun 1986. 84p. (NASA-CR—177161; JPL-PUB—85-101; NAS—1.26:177161). NTIS, PC A04/MF A01.

This report describes 3 MeV proton bombardment experiments on several polymeric materials of interest to NASA carried out on the Tandem Van De Graff Accelerator at the California Institute of Technology's Kellogg Radiation Laboratory. Model aromatic and aliphatic polymers such as poly(1-vinyl naphthalene) and poly(methyl methacrylate), as well as polymers for near term space applications such as Kapton, Epoxy and Polysulfone, have been included in this study. Chemical and physical characterization of the damage products have been carried out in order to develop a model of the interaction of these polymers with the incident proton beam. The proton bombardment methodology developed at the Jet Propulsion Laboratory and reported here is part of an ongoing study on the effects of space radiation on polymeric materials. The report is intended to provide an overview of the mechanistic, as well as the technical and experimental, issues involved in such work rather than to serve as an exhaustive description of all the results.

**6893** **(N—86-28445) Study of the stress wave factor technique for nondestructive evaluation of composite materials. Final report.** Sarrafzadeh-Khoee, A.; Kiernan, M.T.; Duke, J.C. Jr.; Henneke, E.G. II. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Jul 1986. 33p. (NASA-CR—4002; E—3081; NAS—1.26:4002). NTIS, PC A03/MF A01.

The acousto-ultrasonic method of nondestructive evaluation is an extremely sensitive means of assessing material response. Efforts continue to complete the understanding of this method. In order to achieve the full sensitivity of the technique, extreme care must be taken in its performance. This report provides an update of the efforts to advance the understanding of this method and to increase its application to the nondestructive evaluation of composite materials. Included are descriptions of a novel optical system that is capable of measuring in-plane and out-of-plane displacements, an IBM PC-based data acquisition system, an extensive data analysis software package, the azimuthal variation of acousto-ultrasonic behavior in graphite/epoxy laminates, and preliminary examination of processing variation in graphite-aluminum tubes.

**6894** **(N—86-29908) Carbon-rich ceramic composites from ethynyl aromatic precrusors.** Hurwitz, F.I. (Aero Geo Astro Corp., Alexandria, VA (USA)). 1986. 13p. (NASA-TM—88812; E—3167; NAS—1.15:88812). NTIS, PC A02/MF A01.

From 10. annual conference on composites and advanced ceramic materials; Cocoa, Beach, FL, USA (19 Jan 1986).

Sponsored by the American Ceramic Society.

A number of polyfunctional aromatic acetylenes thermally polymerize at low temperatures (180 C) and pyrolyze with greater than 90 char yield. In nonoxidizing environments, they are thermally stable to 1450 C. These monomers were chosen as the basis of a model system to study the fabrication and mechanical properties of continuous filament ceramic matrix composite. Composites were fabricated from aryl poly(acetylenes), SiC particulate filler and graphite, Avco SiC, Nicalon and Nextel fibers. Microstructure, physical and mechanical properties are reported.

**6895** **(PV-M3—27200) Elementary characterization of the Boron 696 epoxy unidirectional preimpregnated fibers.** Laparliere, M. (Centre d'Essais Aeronautique de Toulouse (France)). 1984. 72p. (In French). NTIS, PC A04/MF A01.

The performance of boron fibers produced by a pilot plant was tested, establishing the physical chemical characteristics of the preimpregnated product as well as the mechanical properties of the finished composite. The preimpregnation was done using CIBA Arg 12 epoxy. The mechanical properties are slightly inferior to a reference commercial product. The analysis of the Arg 12 resin shows the same basic constituents as the BSL 914 resin, but in different proportions.

**6896** **Pulsed laser processing of silicon via absorption by free carriers.** James, R.B. (Sandia National Labs., Livermore, CA 94550). pp 127-132 of Advanced processing and characterization of semiconductors III. Sadana, D.K.; Current, M.I. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1986). (CONF-860117—).

From Los Angeles symposium and exhibition on optical and electro-optical engineering; Los Angeles, CA, USA (19 Jan 1986).

Using transmission electron microscopy, the authors show that melting and subsequent defect-free recrystallization can be obtained in silicon by absorbing the pulse energy via free-carrier transitions. They use a pulsed CO/sub 2/ laser to anneal extended lattice defects caused by high-temperature diffusion of phosphorus into lightly doped silicon. For pulse energy densities exceeding a threshold value, they find that the spherical precipitates and dislocation loops in the diffused layer are dissolved by CO/sub 2/ laser-induced melting, which results in a large increase in the electrically active phosphorus in the near-surface region. They also used the differential absorption between layers with different free-carrier concentrations to achieve melting of a buried ion-implanted layer, without melting the material that encapsulates the molten layer. This type of melting phenomenon is likely not obtainable using a laser where the absorption is dominated by an intrinsic mechanism. New applications using free-carrier absorption as a means to process silicon samples are discussed.

**6897** **Structural characterization of defects in GaAs with ultrasonic measurements.** Brophy, M.J.; Granato, A.V. (Electronic Decisions Inc., 1114 W. Springfield Ave., Urbana, IL 61801). pp 13-17 of Advanced processing and characterization of semiconductors III. Sadana, D.K.; Current, M.I. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1986). (CONF-860117—).

From Los Angeles symposium and exhibition on optical and electro-optical engineering; Los Angeles, CA, USA (19 Jan 1986).

Measurements of ultrasonic attenuation and velocity as a function of temperature can yield valuable structural information on defects which lower the symmetry of the lattice site on which they are located. The authors report here on two such defects in GaAs: the Cr impurity and the as yet inconclusively identified defects caused by low temperature irradiation with 2.25-2.5 Mev electrons. The neutral Cr impurity (Cr/sup 3+/-[Ar]3d/sup 3/) traps an electron to become Cr/sup 2+/. This charge state undergoes a static tegragonal Jahn-Teller distortion which can be detected ultrasonically. Ultrasonic measurements at 10 frequencies between 5 and 130 MHz for differing polarizations of the stress wave confirm the tegragonal symmetry of the defect, and provide quantitative information on the kinetics of reorientation between energetically equivalent distortions. Samples with as little as .2 appm Cr were studied.

**6898** **Structure and electrical properties of metal-GaAs interfaces.** Liliental-Weber, Z. (Lawrence Berkeley Lab., Univ. of California, Bldg. 62-203, Berkeley, CA 94720). pp 237-243 of Advanced processing and characterization of semiconductors III. Sadana, D.K.; Current, M.I. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1986). (CONF-860117—).

From Los Angeles symposium and exhibition on optical and electro-optical engineering; Los Angeles, CA, USA (19 Jan 1986).

The structure and related electrical properties of ohmic Au-Ni-Ge contacts, and Schottky: TiSi/sub 2/ and Au contacts are reviewed in this paper. Defects present in GaAs beneath the metal (anion rich - As accumulation) were suggested to be responsible for Schottky level pinning. It was shown that residual oxygen on the GaAs surface prior to metal deposition can strongly influence the interface abruptness, contact parameters and reliability of both ohmic and Schottky contacts.

**6899** **High-pressure release wave measurements and phase transformation in $CACO_3$.** Grady, D.E. (Sandia National Labs., Albuquerque, NM). pp 589-593 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Release-wave measurements on theoretical-density single crystal calcium carbonate from Hugoniot states of 11.5-, 17.9- and 26.4-GPa shock pressure have been performed using time-resolved laser velocity interferometry diagnostics. Samples were subjected to planar impact with metal discs accelerated to high velocity using a powder gun facility. Motion was measured at a diffusely reflecting interface between the sample and lithium fluoride window material. Evidence for a high-pressure phase transformation between 12-14 GPa was provided from the 17.0- and 26.4-GPa experiments in terms of a well-defined rarefaction shock wave. The new phase may be a further metastable phase of calcite or identical to the high pressure state of aragonite.

6900 **Analysis of shock wave structure in single-crystal olivine using VISAR.** Furnish, M.D.; Brown, J.M.; Grady, D.E. (Cornell Univ., Ithaca, NY). pp 595-599 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper presents experiments designed to confirm the existence of a three-wave structure in single-crystal olivine shocked to approximately 18 GPa and to look for orientation dependencies of the shock structure in the hopes of gaining new information about the transition of olivine to spinel. If a transition sensitive to (100) (013) shearing is effective, the authors might predict a lower pressure for the second shock, which reflects the transition, when it promotes such shearing.

6901 **Shock loading and release behavior of X-cut quartz.** Chhabildas, L.C. (Sandia National Labs., Albuquerque, NM). pp 601-605 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Results of release-adiabat measurements are reported for shock-loaded x-cut quartz over the stress range of 15 GPa to 110 GPa. Release paths determined from a shock stress of 15 GPa indicate a return to the original density, while measurements of release adiabats from shock stresses over 50 GPa, suggest release to be occurring primarily from and in the high density phase. Significant hysteretic effects are observed upon release and a retransformation to a low density phase is observed at lower stresses. Measurements of wave speeds in shocked quartz at stresses over 50 GPa indicate a decrease in wave speeds over the stress regime 71 to 108 GPa.

6902 **Studies of the Bauer piezoelectric polymer gauge ($PVF_2$) under impact loading.** Lee, L.M.; Bauer, F.; Graham, R.A.; Williams, W.D. (Ktech Corp.). pp 497-502 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

A cooperative program has been initiated among our laboratories to provide a highly reproducible $PVF_2$ polymer film for widespread use as a gauge under shock-compression loading. The material source and electrical treatment are based on prior work of Bauer, but new, independent studies of gauge response are being carried out. First measurements indicate excellent agreement between the independent studies.

6903 **Polyvinylidene fluoride transducer for dynamic pressure measurements.** Lemar, E.R.; Bur, A.J.; Forbes, J.W.; Tasker, D.G. (Naval Surface Weapons Center). pp 503-508 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper presents some results on the charge output of an electrically poled Polyvinylidene Fluoride (PVDF) gage. This PVDF gage package is of interest because of its large charge output, its low shock impedance, and its nominal thickness of 0.05 mm. It is a good candidate for gage use in materials of low shock impedance because of it creating only a minimum disturbance in the measured wave. The main result of this study was the measurement of the gage output (charge) as a function of stress. A few changes to improve gage accuracy are discussed.

6904 **(N—86-28999) Thermodynamic method of calculating the effect of alloying additives on interphase interaction in composite materials.** Tuchinsky, L.I. Translated from *Fizika i Khimiya Obrabotki Materialov ;* 121-126(1979). 14p. (NASA-TM—88391; NAS—1.15:88391). NTIS, PC A02/MF A01.

The effect of alloying additives to the matrix of a composite on the high temperature solubility rate of a single component fiber was analyzed thermodynamically. With an example of binary Ni alloys, with Group IV-VI transition metals reinforced with W fibers, agreement between the calculated and experimental data was demonstrated.

6905 **(N—86-30518) Preparation and optical properties of GA(x)IN(1-x)P alloys.** Rodot, H.; Horak, J.; Rouy, G.; Bourneix, J. Translated from *Comptes Rendus des Seances de l'Academie des Sciences, Serie B ;* 269: No. 9, 381-384(1 Sep 1969). 9p. (NASA-TM—88431; NAS—1.15:88431). NTIS, PC A02/MF A01.

The solution crystallization method was used to obtain Ga(z)In(1-x)P alloys for all values of x desired between zero and 1. The method of preparation makes it possible to crystallize the solid at a constant temperature. The points obtained by cathodoluminescence are nearly in straight lines. The optical absorption thresholds are confirmed in the results and make it possible to define the nature of the transitions except when x is in the neighborhood of 0.65. These determinations agree with those of Hilsum and Porteus (1968), but are not in agreement with those obtained by Lorenz et al, (1968).

# 40 CHEMISTRY

## 4001 Analytical And Separations Chemistry

*REFER ALSO TO CITATION(S) 6445, 6502, 6502, 6503, 6565, 6580, 6580, 6812, 6835, 6946, 6947, 6947, 7306*

6906 **(CONF-860829—38) Library of convergent beam electron diffraction patterns.** Mansfield, J.F. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001466.

From Annual joint meeting of the Electron Microscopy Society of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Convergent beam electron diffraction (CBED) is used in microanalysis to identify lattice type, point and space group of phases present in a sample. This paper is a brief introduction to the atlas "Convergent Beam Electron Diffraction of Alloy Phases" (Bristol, UK, Adam Hilger). It is planned to update and expand this atlas. Examples are given. (DLC)

6907 **(CONF-860829—39) AEM-based XEDS/EELS microanalysis: a materials science perspective.** Zaluzec, N.J. (Argonne National Lab., IL (USA)). Apr 1986. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001516.

From Annual joint meeting of the Electron Microscopy Society of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Nearly 50% of electron microscopes sold today come equipped for X-ray Energy Dispersive Spectroscopy (XEDS), and Electron Energy Loss Spectroscopy (EELS) is an old analytical technique. This paper outlines the topics involved in a parallel discussion of XEDS and EELS: basic physics, instrumentation, and specimen preparation/handling; basic quantification, advanced topics, and limitations; and future directions and applications. (DLC)

**6908 (DOE/ER/13256—T1) Continuous chemical reaction chromatography. Progress report, December 1984-December 1985.** Aris, R.; Carr, R.W. Jr. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). 1985. Contract FG02-84ER13256. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002037.

In the year since our last progress report, two papers on the theory of the countercurrent moving bed chromatographic (CMCR) reactor were published, and another paper describing the first experiments in a CMCR was accepted for publication. A manuscript describing our first theoretical efforts on the countercurrent moving bed adsorber was finished and submitted for publication. We have completed construction of a re-designed countercurrent moving bed reactor, and have initiated experimentation with it. Theoretical work on a simulated CMCR has progressed to the point that we are now able to do numerical simulations. We have commenced work on the design of a laboratory scale reactor that will be built during the next grant period.

**6909 (K—2051-Rev.1) Empirical cover gas correction, sample freezing time, and air buoyancy adjustment for the analysis of uranium in uranium hexafluoride. Revision 1.** Hedge, W.D. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 29 Aug 1986. Contract AC05-84OT21400. 35p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87002092.

The gravimetric analysis of uranium (U) in uranium hexafluoride ($UF_6$) necessitates subsampling $UF_6$ by transferring an aliquot of liquid $UF_6$ through a vacuum manifold to a polytrifluorochloroethylene (TFCE) vial by cooling with liquid nitrogen. Once frozen, a cover gas is admitted to the vacuum manifold and the vial. The vial is then removed in the cover gas atmosphere and sealed with a nut-plug-gasket assembly. The cover gas is admitted to prevent exposure of the frozen $UF_6$ to moisture in the atmosphere, and the weight of the cover gas then must be considered as part of the gross weight, but not of the net weight of the $UF_6$ within the vial. An air bouyancy correction is also applied to correct for the air displacement of the brass weight equivalents used in obtaining the $UF_6$ new weight. This empirical study concerns (1) the time required to sufficiently cool the $UF_6$ in the sample vial to obtain not only the $UF_6$ but also any residual gases present in the sample, (2) the air buoyancy correction required for determining the net weight of $UF_6$ contained in the sample vial, and (3) the correction for the quantity of cover gas remaining in the sample vial after sealing 4 refs., 7 tabs., 7 figs.

**6910 (LA-UR—86-3465) Optical detection of alkali compounds.** Oldenborg, R.C.; Baughcum, S.L. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 11p. (CONF-860961—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001960.

From Instrumentation, components and materials contractors' meeting; Morgantown, WV, USA (16 Sep 1986).

Experiments to evaluate the photofragment fluorescence diagnostic technique for NaCl, KCl, and NaOH in terms of discrimination potential, sensitivity, and quantitative behavior have been completed. All results so far make this technique look very promising for potential applications in post-combustion coal gas streams. Based on the success of the investigations to date, we are continuing to expand the application of the photofragment technique to other gas-phase alkali compounds of importance in fossil fuel combustion. In particular, work is now in progress to investigate potassium hydroxide, KOH. Ongoing experiments are to determine (1) the optimum wavelength for K* production, (2) whether KOH can be measured in the presence of KCl, (3) if the signals linearly track the KOH monomer density, and (4) the absolute sensitivity of the technique for KOH in high-temperature environments.

**6911 (MHSMP—86-39) Moisture analysis in difficult resin/catalyst matrices.** Ewanowski, L.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Oct 1986. Contract AC04-76DP00487. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002086.

The enhancement of chemical instrumentation offers an improved method for the analysis of moisture in materials that are difficult to dissolve or that tend to alter Karl Fischer reagent. Three instruments other than the distillation method for percent moisture have been used to find that the coulometric titrator equipped with a furnace extractor is able to give very rapid and accurate data. The entire test procedure takes 30 minutes to run triplicate sample. In contrast, the distillation method can take as long as five hours to run only one sample. The resolution improves from a visual reading of 1 - 10 ml on the distillation apparatus to accurately titrated increments of +-2 μg water. 6 figs., 5 tabs.

**6912 (ORNL/TM—10181) HPLC/EC studies of selected explosive components, nitroanilines, and nitrophenols with dual electrode electrochemical detection. Final report.** Manning, D.L.; Maskarinec, M.P. (Oak Ridge National Lab., TN (USA)). Oct 1986. Contract AC05-84OR21400. 26p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87002338.

The dual electrode electrochemical detector has greatly enhanced high pressure liquid chromatography/electrochemical detection (HPLC/EC) capability. The most fruitful mode of operation is in the dual parallel electrode configuration. The ability to assess peak purity in real samples is very beneficial. Simultaneous recording of cathodic and anodic chromatograms to look for possible impurities and munition decomposition products is an added technique to ascertain sample purity. The extent of electrode "crosstalk" can be minimized by repeating the experiment with the Au/Hg electrode "OFF." In view of the low collection efficiencies encountered, the dual series mode of operation, at present, is of limited practical value for these types of electroactive substances. 5 refs., 9 figs., 2 tabs.

**6913 (RISO-M—2599) Determination of fission products in irradiated fuel by X-ray fluorescence.** Mogensen, M.; Als-Nielsen, J.; Hessel Andersen, N. (Risoe National Lab., Roskilde (Denmark)). Aug 1986. 21p. (CONF-8605196—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750157.

From EEC hot laboratories meeting; Brasimone, Italy (21 May 1986).

X-ray fluorescence is a well established analytical tool for measuring elemental composition of fairly large (approximately 5 $cm^3$) "cold" samples. A version of this technique has been developed for analysis of radial distribution of fission products Xe, Cs and Ba in irradiated $UO_2$ fuel samples. About 0.1 mm thin slices of fuel pellets (full cross sections) are irradiated by 50 keV X-rays. The intensity of the Xe (Cs, Ba) K $\alpha$ fluorescence radiation generated is measured by means of a Ge detector fitted with a collimator. The slit is 0.5 mm wide in the scanning direction and 2 mm long. The measured Xe K $\alpha$ X-ray intensities are converted to absolute concentrations by comparing to the intensity from a Xe gas standard. In the case of Cs and Ba solid standards may be used. The X-ray fluorescence analysis is compared to other techniques used to obtain radial fission product profiles. It is shown how a combination of X-ray fluorescence and electron probe micro analysis is able to reveal the amount of Xe in the grain boundary porosities.

**6914 (SAND—86-2315C) Comparison of 14 MeV neutron activation analysis and competitive methods for determination of oxygen, nitrogen, silicon, fluorine and other elements.** Bild, R.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 18p. (CONF-8610149—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001734.

From Advisory group meeting on comparison of nuclear analytical methods with competitive methods; Oak Ridge, TN, USA (3 Oct 1986).

14 MeV neutron activation analysis (14 MeV NAA) makes use of small particle accelerators to produce 14 MeV neutrons from the D-T reaction. The neutrons produce radioactive isotopes in samples by the reactions (n,p), (n,2n) and (n,$\alpha$). Gamma rays emitted are counted to determine the amount of the target element present. Major applications have been determination of total O, N or Si in solid and liquid matrices, but the technique can also be applied to determine concentrations of about 30 other elements including F, Cl, Al, P and Mg. Detection limits are a few micro-

grams in the best cases and milligrams for most others. The method has advantages of being nondestructive, fast and insensitive to sample inhomogeneities. It lends itself especially well to sequential analysis of the same sample by several techniques and to samples that are difficult to dissolve. Portable generators have been applied to industrial situations and to well logging. Major disadvantages are the necessity to house a radiation producing instrument, the cost of the equipment and the lack of useful neutron reactions for some important elements. Accuracy (typically +-7 to 10% relative) and precision (+-1 to 5% relative) are comparable to competing techniques. For determination of low levels of O and N in most metals inert gas fusion is more rapid and sensitive; elemental analyzer is more sensitive for O and N in organics. Wet chemical methods rarely have any advantage over 14 MeV NAA for solid samples when concentrations are in the detection limit range of the 14 MeV NAA methods. Future developments in the field will come in the areas of simpler, more portable and higher neutron output generator designs. 66 refs.

6915 **(ORNL/tr—86/47) Process for isolating and purifying antibiotics.** Coenen, H.; Hagen, R. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. Translation of . 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001641.

A process for isolating and purifying antibiotics is proposed in which an antibiotic-containing solution is extracted by means of an extraction agent at a temperature of 0 to 40° and at a pressure between the critical pressure and the ten-fold value of the critical pressure of the extraction agent, whereby the weight ratio of antibiotic-containing solution to extraction agent shall be from 1:5 to 1:20, in which process the antibiotics are precipitated from the antibiotic-containing extraction agent by lowering its density and in which the extraction agent is run in a cycle. A solvent enhancer can be added to the extraction agent. The density of the antibiotic-containing extraction agent can be reduced by reducing the pressure to 30 to 70 bar.

6916 **Potentiometric precipitation titrations of selenite, selenate, tellurite and tellurate.** Selig, W.S. (California Univ., Livermore, USA. Lawrence Livermore National Lab.). *Mikrochimica Acta;* **2**: No. 3-4, 127-136(1985).

Some precipitation titrations have been evaluated for the determination of the oxo anions of selenium and tellurium. Selenite and tellurite can be titrated with sodium diethyldithiocarbamate, using a silver ion-selective electrode as sensor. Tellurite can be titrated with cetylpyridinium chloride, using a poly(vinylchloride)/dioctylphthalate-coated graphite rod as sensor. Silver nitrate can be used to titrate selenite, tellurite, and tellurate. While the sum of tellurite and tellurate can be estimated, no sequential titration is possible. Lead nitrate can be used for the titration of selenite in the presence of selenate, in aqueous solution. In 80% methanolic solution the sum of selenite and selenate is titrated with lead nitrate.

6917 **Analytical capabilities of RIMS: absolute sensitivity and isotopic analysis.** Nogar, N.S.; Downey, S.W.; Miller, C.M. (Los Alamos National Lab., NM). *Institute of Physics, Conference Series;* No. 71, 91-94(1984).

From RIS; Knoxville, TN, USA (16-20 Apr 1984).

Results of isotope ratio measurements carried out on 60-200 ng lutetium samples are reported. High resolution optical spectra of lutetium isotopes were generated using resonance ionization mass spectrometry (RIMS) as a preclude to isotopically selective resonance ionization. Analytical measurements were carried out using a magnetic mass spectrometer and broadband cw dye laser radiation. Major isotopes were measured using current detection, while pulse counting was used for minor isotopes. Results are also presented for the two-color spectroscopic studies for isotope ratio measurements in technetium. 20 references, 2 figures, 1 table.

6918 **Purification and analysis of calcium carbonate with a poly(dithiocarbamate) resin.** Mahanti, H.S.; Barnes, R.M. (Univ. of Massachusetts, Amherst). *Applied Spectroscopy;* **37**: No. 4, 401(1983).

A method is described for purification of reagent-grade calcium salts for use in spectrochemical studies of trace element contents of animal and human bone. The $CaCO_3$ dissolved in HCl-$HNO_3$ aqueous solutions at pH 5 is equilibrated with the poly(dithiocarbamate) resin to complex and remove metals such as Cu, Ni, Co, Ti, V, Ni, Pb, Mo, and Cd. The effectiveness of element removal is measured by analyzing the content of elements in the resins. 14 references.

6919 **Competitive transport of alkali metal ions from aqueous media into toluene solutions of 2-(sym-dibenzo-16-crown-5-oxy)-decanoic acid. A comparative study.** Charewicz, W.A.; Bartsch, R.A. (Texas Technological Univ., Lubbock). *Journal of Membrane Science;* **12**: 323-333(1983). Contract AS05-80ER10604.

Competitive permeation of alkali metal ions from an alkaline source phase into or through a toluene phase facilitated by the lipophilic crown ether carboxylic acid 2-(sym-dibenzo-16-crown-5-oxy)-decanoic acid is studied in liquid-liquid extraction, bulk liquid membrane transport, and emulsion liquid membrane transport. Most rapid transport was obtained in emulsion liquid membrane experiments. Some differences in selectivity orders for alkali metal permeation were observed for the three separation techniques. 19 references, 6 figures, 1 table.

6920 **Distribution and miscibility limits in the system ethanol-water-tri-n-butyl phosphate-diluent.** Roddy, J.W.; Coleman, C.F. (Oak Ridge National Lab., TN). *Industrial and Engineering Chemistry Fundamentals;* **22**: No. 1, 51-54(1983). Contract W-7405-ENG-26.

Distribution coefficients of ($^{14}$C-) ethanol, D/sub EtOH/, and ($^{3}$H-) water, D/sub HOH/, from aqueous solutions to TBP/n-octane were measured at 25°C. With undiluted TBP and > 5 M aqueous ethanol, D/sub EtOH is near unity; it decreases with dilution of either phase to about 0.005 at 0.03 M TBP and 0.01 M aqueous ethanol. The corresponding D/sub HOH decreases from about 0.1 to 0.00003, so that the separation factor D/sub EtOH//D/sub HOH/ increases from about 9 to about 160. The four-component phase diagram contains one (three-dimensional) two-phase region, which shows that the maximum aqueous ethanol product concentration would be around 90 wt % in extraction with 1 M TBP and 65 wt % with undiluted TBP. Infrared spectral data in the frequency range of the hydroxyl and phosphoryl stretching modes were analyzed to assess the shifting nature of the intermolecular bonding, although they were not sufficient to identify the individual species. 13 references, 5 figures, 1 table.

6921 **Complex formation in dilute aqueous solutions of europium perchlorate detected through fluorescence lifetime measurements.** Giuliani, J.F.; Donohue, T. (Naval Research Lab., Washington, DC). *Inorganic Chemistry;* **17**: No. 4, 1090-1091(1978). Contract AI01-76ET32016.

Substantial changes have been noted in the lifetime of $Eu^{3+}$ ($^{5}D_0$) fluorescence when the perchlorate concentration was varied at low levels. The fluorescence decays were found to be first order. The results reported here clearly demonstrate that ion-pair formation is significant at concentrations much lower than have been previously assumed. The method described here appears to have the advantages over conventional techniques of being relatively easy and offering the possibility of determination of much lower concentration. 22 references, 1 figure.

6922 **(N—86-29007) Development of a potentiometric EDTA method for determination of molybdenum. Use of the analysis for molybdenite concentrates.** Khristova, R.; Vanmen, M. Translated from *Godishnik na Sofiiskiya Universitet, Khimicheski Fakultet ;* 243-251(1976). 13p. (NASA-TM—88460; NAS—1.15:88460). NTIS, PC A02/MF A01.

Based on considerations of principles and experimental data, the interference of sulfate ions in poteniometric titration of EDTA with $FeCl_3$ was confirmed. The method of back complexometric titration of molybdenum of Nonova and Gasheva was improved by replacing hydrazine sulfate with hydrazine hydrochloride for reduction of Mo(VI) to Mo(V). The method can be used for one to tenths of mg of molybdenum with 0.04 mg standard deviation. The specific method of determination of molybdenum in molybdenite concentrates is presented.

## 4002 Inorganic, Organic And Physical Chemistry

*REFER ALSO TO CITATION(S) 6398, 6433, 6434, 6444, 6456, 6491, 6669, 6813, 6813, 6856, 6918, 6920, 6920, 6920, 6921, 6946, 6949, 6950, 6956, 7417, 7484*

**6923 (BNL—38696) Adsorption of simple molecules ($H_2$, $O_2$, CO) on Mn/Ru(001) surfaces.** Hrbek, J. (Brookhaven National Lab., Upton, NY (USA). Chemistry Dept.). 1986. Contract AC02-76CH00016. 4p. (CONF-861019—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001371.

From 10. international vacuum congress and 6. international conference on solid surfaces and the 33. national symposium of the American Vacuum Society; Baltimore, MD, USA (27 Oct 1986).

Among the 3d transition metals manganese has unusual physical properties and distinct chemical behavior, but its surface chemistry is still largely unexplored. A need for a more precise understanding of its chemisorptive properties arises in a view of recent discoveries of Mn based supported catalysts for the oxidative coupling of methane, and cracking of low molecular weight paraffins. So far the chemisorption studies were carried out on polycrystalline films and bulk polycrystalline samples. Although the ordered Mn overlayers grown on oriented single crystal surface were characterized structurally, the adsorption properties of well defined Mn layers are unknown. The immiscibility of Mn and Ru facilitates the coverage determination, which is not complicated by the formation of 3-D alloy. The experiments described here were carried out under UHV conditions ($P_0 < 1.10^{-10}$ Torr) using work function measurements ($\Delta$ phi), thermal desorption (TDS) and photoelectron spectroscopies (UPS and XPS) and low energy electron diffraction (LEED) for surface and adsorbates characterization. Mn was deposited from a shielded evaporator with shutter and its coverages were determined by TDS and XPS. 10 refs.

**6924 (CEA-CONF—8456) Electrostatic crystal field of the uranium coordination compound: U(tfba)$_4$.** Soulie, E.; Faucher, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 3p. (In French). (CONF-8604262—3-Summ.). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750243.

From 16. meeting on actinides; Eibsee, F.R. Germany (28 Apr 1986).

Published in summary form only.

**6925 (DOE/ER/10634—1) Dynamics of vapor explosions. Final technical report.** Sturtevant, B. (California Inst. of Tech., Pasadena (USA). Graduate Aeronautical Labs.). 28 Oct 1986. Contract AS03-80ER10634. 53p. NTIS, PC A04. File Number DE87002212.

This report is divided into two parts, describing the results of two major projects carried out since the inception of the research. Part one deals with dynamics of explosive boiling of a droplet. The dynamical behavior of unstable boiling of single droplets (1 to 2 mm diameter) of several hydrocarbons, butane, pentane, isopentane and ethyl ether, at the superheat limit is exhibited in detail. In part two, shock-induced explosive boiling of a droplet, the role of incident shock waves in the initiation of vapors explosions in volatile liquid hydrocarbons, isopentane and ethyl ether, is investigated. A simple calculation is given, which suggests that shock focusing may influence the location at which unstable boiling is initiated. 45 refs., 25 figs. (AT)

**6926 (DOE/ER/13277—T1) Comprehensive characterization studies of sulfided molybdena catalysts. Progress report, second year.** Massoth, F.E. (Utah Univ., Salt Lake City (USA). Dept. of Fuels Engineering). Jun 1985. Contract FG02-84ER13277. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002038.

Some forty additional molybdena catalysts supported on various aluminas were prepared and tested for thiophene hydrodesulfurization (HDS) activity. About one-half of these were further characterized by various techniques. No molybdenum phases were detected by x-ray diffraction up to Mo levels of 12%. ESCA analyses indicated a probable monomolecular dispersion of the Mo in the oxide catalysts and $CO_2$ adsorption confirmed a monolayer dispersion in the sulfide catalysts. Chemisorption of NO on the sulfide catalysts showed an approximate correlation with thiophene HDS activity, which most likely reflects the $MoS_2$ cluster size rather than the active site concentration. Thiophene HDS activity also showed a rough correlation with the "active" hydroxyl content of the support, indicating that the $MoS_2$ cluster size may be determined by the interaction of a molybdenum precursor with the support OH content. The results obtained thus far are giving us a clearer picture of the structure of the active phase present in these catalysts, although the nature and concentration of the catalytically active sites are still not well known. Comparison of thiophene HDS activity at atmospheric pressure with that of dibenzothiophene activity at elevated pressure showed the same relative ranking of catalyst activities, indicating that the former is a valid test for assessing HDS activity of these catalysts. 2 figs.

**6927 (DOE/ER/13299—3) Diosmacycloalkanes as models for the formation of hydrocarbons from surface methylenes: Progress report.** Norton, J.R. (Colorado State Univ., Fort Collins (USA). Dept. of Chemistry). Oct 1986. Contract FG02-84ER13299. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001903.

The report of progress to date includes discussions of the following subjects: improved routes to basic organoosmium complexes; new and improved preparations of diosmium dialkyls and diosmacycloalkanes from $Na_2[Os_3(CO)_8]$; new, improved, and stereospecific preparations of ditriflates; carbonyl insertion by diosmium dialkyls and diosmacycloalkanes; stereospecific and reversible olefin loss from diosmacyclobutanes; olefin loss from other diosmacycloalkanes and the corresponding monoosmacycloalkanes; spectroscopic characterization of diosmacycloalkanes for use in the identification of surface species. Plans for future research are also reported. 68 refs. (PLG)

**6928 (N—86-29024) Correlation of structural, chemical, and electronic properties of small metal particles and their alloys. Final technical report, 20 May 1982-31 July 1983.** (Eloret Corp., Sunnyvale, CA (USA)). Jul 1983. 25p. (NASA-CR—177116; NAS—1.26:177116; EI—84-0408). NTIS, PC A02/MF A01.

The low pressure interaction of CO with small Ru particles supported on ultrahigh vacuum (UHV) cleaved mica was studied using flash thermal desorption, Auger electron microscopy, transmission electron microscopy, and transmission electron diffraction. Average particle sizes for these experiments varied between 1.2 and 16 nm. A careful search for CO decomposition on the Ru particles revealed no evidence of dissociaiton over a temperature range and pressure range of 300 to 550 C and 10 to the minus 11th power to 10 to the minus 6th millibar, respectively. Cas and heat treatments caused significant morphological changes and dispersion in the Ru particles, which affected CO desorptiom. These effects were dependent on the particle size.

**6929 (N—86-31037) Design and chemical synthesis of iodine-containing molecules for application to solar-pumped I* lasers. Semiannual progress report, 1 January-30 June 1986.** Shiner, C.S. (Colorado Univ., Boulder (USA). Cooperative Inst. for Research in Environmental Sciences). 1986. 4p. (NASA-CR—176854; NAS—1.26:176854). NTIS, PC A02/MF A01.

The design and chemical synthesis of new media for solar pumped iodine molecule lasers are explored. In an effort to prepare an iodo fluorocarbon compound absorbing strongly at 300 nm or above, the synthesis of perfluoro allylic iodides was investigated. These compounds furnish especially stable allylic radicals upon photodissociation. The desired red shift is anticipated in the absorption maximum could correlate with increasing radical stability. This expectation was based upon the analysis, previously reported, of the structures and absorption maxima of compounds studied earlier. A previously unknown substance was prepared, a prototypical target molecule, perfluoro-3-iodocyclopent-1-ene. It was obtained by reaction of perfluorocyclopentene with sulfur trioxide under the influence of antimony pentafluoride catalyst, followed by treatment of the resulting allylic fluorosulfonate with sodium iodide in sulfoland

solvent. Preliminary data indicate that the absorption maximum for the iodo fluorocarbon is not shifted significantly to longer wavelength. It is not certain whether this result reflects an unexpected influence of the cyclic structure upon the position of the absorption maximum.

6930 **Solid-state oxygen-17 nuclear magnetic resonance spectroscopic studies of zeolites and related systems. 1.** Timken, H.K.C.; Turner, G.L.; Gilson, J.P.; Welsh, L.B.; Oldfield, E. (Univ. of Illinois, Urbana-Champaign). *Journal of the American Chemical Society;* **108**: No. 23, 7231-7235(12 Nov 1986). Contract FG22-83PC60779.

The authors have obtained static, magic-angle, and variable-angle sample-spinning $^{17}O$ NMR spectra of $^{17}O$-labeled A, Y, and dealuminated Y zeolites at 67.8 and 48.8 MHz (corresponding to magnetic field strengths of 11.7 and 8.45 T). The results indicate that the ranges of $^{17}O$ nuclear quadrupole coupling constants ($e^2aQ/h$) of the Si[$^{17}$O]Al and Si[$^{17}$O]Si fragments are 3.1-3.2 and 4.6-5.2 MHz, respectively, in general agreement with those predicted on the basis of the empirical correlation presented previously (Schramm, S.: Oldfield, E. J. Am. Chem. Soc. 1984, 106, 2502). The asymmetry parameters are 0.2 for Si[$^{17}$O[Al and 0.1 for Si[$^{17}$]Si. The isotropic chemical shifts of the Si[$^{17}$O]Al fragments are in the range of 31-45 ppm relative to $H_2O$, while those of the Si[$^{17}$]Al fragments are in the range of 44-57 ppm.

6931 **Solid-state oxygen-17 nuclear magnetic resonance spectroscopic studies of zeolites and related systems. 2.** Timken, H.K.C.; Janes, N.; Turner, G.L.; Lambert, S.L.; Welsh, L.B.; Oldfield, E. (Univ. of Illinois, Urbana-Champaign). *Journal of the American Chemical Society;* **108**: No. 23, 7236-7241(12 Nov 1986). Contract FG22-83PC60779.

The authors have obtained solid-state $^{17}O$ NMR spectra of $^{17}O$-enriched gallosilicates (gallium analogues of zeolite Na-X, sodalite, and $Ba^{2+}$-exchange sodalite) and the porous aluminophosphates ($AlPO_4$-5, $AlPO_4$-11, and $AlPO_4$-17). The spectra yield nuclear quadrupole coupling constants ($e^2qQ/h$), electric field gradient tensor asymmetry parameters (eta), and isotropic chemical shifts (δ/sub i/) for the chemically distinct oxygens in the Si-O-Ga, Si-O-Si, and Al-O-P fragments. The $e^2qQ/h$ values for these species, and for Si-O-Si and Si-O-Al in Na-A and Na-Y zeolites, are analyzed in terms of a Townes-Dailey theory, and the results are compared with the predictions of a previous wholly empirical approach. The results suggest that the empirical approach gives the best agreement between experiment and prediction when nonframework counterions are present (e.g., Si-O-Al, Si-O-Ga), but that the Townes-Dailey approximation yields the most accurate predictions in the absence of such species (e.g., Al-O-P).

6932 **Fluidizing device for solid particulates.** Diebold, J.P.; Scahill, J.W. (to Dept. of Energy, Washington, DC). US Patent 4,620,795. 4 Nov 1986. Filed date 27 Jun 1984. v.p.

An apparatus is described for facilitating a flow of solid particulates through an orifice of a hopper comprising: (a) a flexible whip including two transversely spaced elongated members, the two elongated members being connected to one another at opposed ends thereof; (b) means for mounting the whip in a generally vertical orientation within the hopper such that one end of the whip is freely suspended above the orifice; (c) means for causing the whip to rotate about a substantially vertical axis defined by the hopper such that each one of the two elongated members are caused to independently impact and fluidize the solid particulates within the hopper, and wherein an anchor is affixed to the freely suspended end of the whip, and wherein the anchor comprises: (i) a rigid longitudinal member having a first and a second end, the first end being connected to the freely suspended end of the whip; and (ii) a spiral member which is supportedly connected to the second end of the longitudinal member.

6933 **Sewage sludge dewatering using flowing liquid metals.** Carlson, L.W. (to Dept. of Energy, Washington, DC). US Patent 4,620,493. 4 Nov 1986. Filed date 30 Aug 1985. v.p.

A method is described of reducing the moisture content of a moist sewage sludge having a moisture content of about 50-80% and formed of small cellular micro-organism bodies having internally confined water. The method comprises: circulating a hot liquid metal in a loop; forming a mixture of the moist sludge and the hot liquid metal in a portion of the loop under conditions of temperature and pressure such that the confined water vaporizes and ruptures the cellular bodies; separating the liquid metal, dried sludge, and vaporized water in a separation zone of the loop; and drawing off the dried sludge and vaporized water from the loop whereby the liquid metal is left to be recirculated in the loop.

6934 **Organometallic chemistry of rhodium tetraphenylporphyrin derivatives: formyl, hydroxymethyl, and alkyl complexes.** Wayland, B.B.; Van Voorhees, S.L.; Wilker, C. (Univ. of Pennsylvania, Philadelphia). *Inorganic Chemistry;* **25**: No. 22, 4039-4042(22 Oct 1986). Contract AC02-83ER13133.

Organometallic reactivity patterns of the rhodium tetraphenylporphyrin derivatives Rh(TPP)(H), Rh(TPP)$^-$, and (Rh(TPP))$_2$ are found to closely parallel those of the corresponding rhodium octaethylporphyrins species. Preparation and physical properties of the formyl, hydroxymethyl, and alkyl complexes of Rh(TPP) are described along with the photoinduced insertion of carbon monoxide into the Rh-$CH_3$ bond. Thermodynamic values for the reaction Rh(TPP)(H) + CO ⇌ Rh(TPP)(CHO) in $C_6D_6$ are $\Delta H^\circ$ = -42 kJ/mol and $\Delta S^\circ$ = -89 +/- 15 J/(K mol).

6935 **Selective removal of oxygen from rare earth and thorium metals through oxyhalide formation.** Corbett, J.D.; Smith, J.D.; Garcia, E. (Ames Lab., IA, USA; Iowa State Univ. of Science and Technology, Ames, USA. Dept. of Chemistry). *Journal of the Less-Common Metals;* **115**: No. 2, 343-355(15 Jan 1986).

The reactions of yttrium, lanthanum, neodymium and gadolinium metals containing 1-5 at.% dissolved oxygen with the respective trichlorides $RCl_3$ to produce ROCl as well as the reverse reactions of ROCl with pure lanthanum and gadolinium in the presence of $RCl_3$ have been studied in sealed niobium or tantalum containers. Such reactions at 730-850°C for 1-2 weeks duration yield metal containing 0.1-0.2 at.% oxygen, consistent with thermodynamic estimates for the reaction limits. Precipitation of LaOCl within the low-melting lanthanum metal limits the removal of 2-5 at.% oxygen at 850°C to about 0.5 at.% but this limit can be decreased to about 0.27% by longer reactions at 760-775°C. These types of reactions appear general for the selective removal of oxygen from nearly all the rare earth metals. Similar reactions reduced the level of precipitated oxygen in thorium from 1.1 to 0.1 at.% although a much lower value is predicted from thermodynamic data. Enthalpy changes and very low theoretical limits that are equally, or more favorable, are also found for the comparable removal of oxygen from uranium, plutonium, americium and curium (A) via the formation of AOCl or AOBr.

6936 **Subthreshold generation of free radicals in shock-loaded organic solids.** Dodson, B.W.; Rogers, J.W. Jr.; Venturini, E.L. (Sandia National Labs., Albuquerque, NM). pp 897-901 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper studies the generation of free radicals in organic solids, both non-energetic and explosive, at pressures below the threshold for gross reactivity, in an attempt to sort out the importance of the mechanisms through which a shock wave can induce chemical reactivity in organic solids. The technique utilized here is to shock-load an organic sample, recover the sample, and measure the electron-spin resonance spectrum to determine the post-shock free radical density. Results are presented from this technique and in some cases other analytical techniques.

6937 **Intramolecular reductive elimination of methane from a dinuclear palladium complex containing methyl and hydride on adjacent palladium centers.** Kellenberger, B.; Young, S.J.; Stille, J.K. (Colorado State Univ., Fort Collins). *Journal of the American Chemical Society;* **107**: No. 21, 6105-6107(1985). Contract AC02-78ER04903.

The preparation, isolation, and determination of structure of a dinuclear palladium complex containing methyl and hydride on adjacent palladium atoms its facile 1,1-dinuclear intramolecular elimination of methane are reported. The complex was isolated as its tetraphenylborate salt and was fully characterized including its x-ray structure. Reductive elimination from the deuterated complex containing deutride on one palladium and trideuteriomethyl on the other gave a quantitative yield of methane. 16 references, 3 figures.

6938 **Low-lying $^1D$ states of BeI.** Fischer, C.F. (Vanderbilt Univ., Nashville, TN). *Physical Review [Section] A: General Physics;* **30**: No. 5, 2741-2744(Nov 1984). Contract AS05-80ER10618.

The composition of the three lowest $^1D$ states of BeI has been investigated using the multiconfiguration Hartree-Fock method. Though the $2p^2$ configuration lies above the 2s4d configuration in the Hartree-Fock approximation, correlation in the localized $2[^2$ configuration and its interaction with the higher-lying Rydberg series, including the continuum, are such that the $2p^2$ state is depressed to the extent that the lowest $^1D$ state is predominately $2p^2$, the second largely 2s3d, and the third almost entirely 2s4d. 8 references, 2 figures, 3 tables.

6939 **Solvation emission spectral peaks of singlet molecular oxygen.** Chou, P.T.; Khan, A.U. (Florida State Univ., Tallahassee). *Chemical Physics Letters;* **103**: No. 4, 281-284(6 Jan 1984). Contract AS05-78EV05855.

Distinct new emission peaks of solvated singlet ($^1\Delta$/sub g/) molecular oxygen, generated by photosensitization, are observed in a series of oxygen-saturated halogenated organic solvents at room temperature. The observed red-shift in the emission is characteristic of the halogen atom (e.g. F > Cl > Br) of the solvent. The emission is assigned to simultaneous electronic-vibrational transitions involving the electronic ($^1\Delta$/sub g/) state of the oxygen molecule and the vibrational states of the solvent molecule. The authors also suggest that the intensity of this spin-forbidden transition is borrowed from the Schumann-Runge band of oxygen via spin-orbit coupling in a solvated oxygen species in which the $\Delta$ state degeneracy is removed. This interpretation correlates previous observations of increased oscillator strength in dissolved singlet oxygen with the appearance of the new peaks assigned to simultaneous electronic-vibrational transitions reported here. 16 references, 1 figure, 2 tables.

6940 **Search for singlet oxygen luminescence in the disproportionation of $HO_2/O_2^-$.** Arudi, R.L.; Bielski, B.H.J.; Allen, A.O. (Brookhaven National Lab., Upton, NY). *Photochemistry and Photobiology;* **39**: No. 5, 703-706(1984).

During the reaction $HO_2 + HO_2$ (or $O_2^-$) = $H_2O_2 + O_2$ in aqueous solution, no luminescence in the region 620-720 nm, expected if the product $O_2$ were formed in a singlet state, could be detected. If any singlet $O_2$ is formed, its yield must be less than 10%. Faint luminescence, sometimes found at shorter wavelengths, was shown to arise from reaction of $HO_2$ with impurities in the reagents present. 9 references, 4 figures, 3 tables.

6941 **Mutual diffusion coefficients of $ZnCl_2$-$H_2O$ at 298.15 K by Rayleigh interferometry.** Rard, J.A.; Miller, D.G. (Lawrence Livermore National Lab., CA). *Zeitschrift fuer Physikalische Chemie, Frankfurter Ausgabe, Neue Folge;* **142**: 141-155(1984). Contract W-7405-ENG-48.

Volume fixed mutual diffusion coefficients have been measured for aqueous $ZnCl_2$ solutions from 0.005 to 5.652 mol x $dm^{-3}$ at 298.15 K using free-diffusion Rayleigh interferometry. Most experiments were for stoichiometric high purity solutions, but solutions with either a 0.14% excess or several hundredths of a percent deficiency of HCl were also investigated. These minor deviations from stoichiometry had no detectable effect on the diffusion coefficients; thus hydrolysis does not affect the results. The $ZnCl_2$ diffusion coefficients exhibit a shoulder around 0.2 mol x $dm^{-3}$ that may be due to self-complexing. Related anomalies in tracer diffusion coefficients of the $H_2O$, in viscosities, and in activity coefficient derivatives of $ZnCl_2$ solutions have been reported by other workers. These anomalies appear to be characteristic of and limited to zinc halide solutions. Two commercial soures of $ZnCl_2$ were found to contain large amounts of alkali metal and alkaline earth metal impurities; these impurities raise the diffusion coefficients but have little effect on the anomaly. Thermodynamic diffusion coefficients were calculated for $ZnCl_2$ solutions and compared to similar data for other 2-1 chlorides; of the salts studied so far, $ZnCl_2$ is unique with its double maxima. 31 references, 5 figures, 3 tables.

6942 **Effect of ionic strength on acid-base equilibria of charged ions in highly basic media.** Schuler, R.H.; Taniguchi, H. (Univ. of Notre Dame, IN). *Journal of the American Chemical Society;* **106**: 1507-1508(1984).

Results of studies reported herein demonstrate that the overall reaction constant for the reaction of an organic acid, $AH^-$, with $OH^-$ to yield reversibly $B^{2-}$ and water increase significantly with increased ionic strength. Some observations are made on the $H^-$ and $H^{2-}$, scales which effectively extend the normal pH scale. The comments made are based on data from studies involving examination of deprotonation of carboxylated hydroxycyclohexadienyl radicals by ESR methods. The radicals of interest resulting from OH addition were produced by electron beam irradiation of $N_2O$-saturated basic solutions of carboxylated benzene directly in the ESR cavity. 12 references, 1 figure.

6943 **Preparation and use of $W(CO)_3(NCR)_3$ (R = Et, Pr) as improved starting materials for syntheses of tricarbonyl(eta$^6$-cycloheptatriene) tungsten and other substituted carbonyl complexes.** Kubas, G.J. (Los Alamos National Lab., NM). *Inorganic Chemistry;* **22**: No. 4, 692-694(1983).

The problems of slow rates of formation of $W(CO)_3(NCMe)_3$ where Me=methyl for preparation of tungsten complexes by refluxing in MeCN and the complex's poor solubility in nearly all organic solvents have been circumvented by using propionitrile or even higher boiling homologues in place of MeCN. The resulting complexes $W(CO)_3(NCR)_3$ (R=Et, Pr) have been characterized and have been found to be excellent starting materials for the syntheses of polyolefin complexes such as $W(CO)_3$(cht) (cht = eta$^6$-cycloheptatriene and phosphine-containing complexes. The $W(CO)_3$(cht) complex was produced in a 49% yield by the large-scale reaction of $W(CO)_3(NCEt)_3$ and cyclohyptatriene. Even more remarkable was the 51% yield when this method was used to produce $W(CO)_3$(chd) (CHD = 1,3-cyclohexadiene). 1 table.

6944 **Platinum(0) complexes with bulky phosphines: trinuclear $SO_2$ and $CS_2$ complexes.** Ritchey, J.M.; Moody, D.C. (Los Alamos National Lab., NM). *Inorganica Chimica Acta;* **74**: 271-274(1983).

The synthesis and reaction chemistry of a series of trinuclear $SO_2$ and $CS_2$ complexes containing the bulky phosphines tricyclohexylphosphine ($PCy_3$) and tri-t-butylphosphine ($P(t\text{-}Bu)_3$) are reported. 16 references, 1 table.

6945 **Fluorescence and triplet yield quenching of $\beta$-apo-14′-carotenal ($C_{22}$ aldehyde) by aromatic molecules.** Selvarajan, N.; Das, P.K.; Hug, G.L. (Univ. of Notre Dame, IN). *Journal of Photochemistry;* **20**: 355-366(1982).

The fluorescence and triplet yields of $\beta$-apo-14′-carotenal in cyclohexane at room temperature are quenched in the presence of submolar concentrations of aromatic molecules predominantly through a dynamic interaction. The observed Stern-Volmer constants K/sub SV//sup F/ for fluorescence quenching vary from 0.06 $M^{-1}$ for mesitylene to 45 $M^{-1}$ for indole, giving excited state quenching rate constants in the range $6 \times 10^7$ - $4.5 \times 10^{10}$ $M^{-1}$ $s^{-1}$. With methoxy-substituted benzene derivatives as quenchers, the K/sub SV//sup F/ data correlate well with the half-wave oxidation potentials of the quenchers, suggesting a modest involvement of charge transfer. Interestingly, the Stern-Volmer constants K/sub SV//sup F/ values. This result is explained in terms of scheme(s) where the singlet excited state species that acts as precursor for triplet is assumed to be kinetically distinguishable from that responsible for fluorescence. 17 references, 5 figures, 2 tables.

## 4004 Electrochemistry

*REFER ALSO TO CITATION(S) 6833*

**6946 The role of strong metal support interactions in RuO/sub 2//Ti electrocatalysts.** O'Grady, W.E.; Atanasoski, R. (Brookhaven National Lab., Dept. of Applied Science, Upton, NY 11973). pp 502 of Proceedings of the 1986 Spring meeting of the Electrochemical Society. Vol. 86-1. Pennington, NJ; The Electrochemical Society (1986). (CONF-860540—). Contract AC02-76CH00016.

From 169. meeting of the Electrochemical Society; Boston, MA, USA (4 May 1986).

In order to focus on the RuO/sub 2//Ti interface a series of experiments on single crystal RuO/sub 2/ have been carried out. The surface structure and composition of the clean well annealed RuO/sub 2/ crystals have been determined by LEED, Auger, and XPS. Onto the characterized RuO/sub 2/ surfaces, well defined submonolayer quantities of titanium metal have been evaporated. The evolving structure and composition were monitored with LEED, Auger, and XPS. On the well annealed single crystal surfaces RuO/sub 3/ was always observed even when the surface is depleted of oxygen. When the RuO/sub 2/ decomposes with heating in the vacuum system only oxygen is lost and ruthenium metal is formed. During this decomposition RuO/sub 3/ is always observed. A mechanism consistent with these observations suggests that oxygen diffuses to the surface forming RuO$_3$/sub 3/ which then disproportionates into Ru metal and RuO/sub 2/. When the Ti metal is evaporated onto the surface it reacts with the RuO/sub 3/ yielding titanium oxide. This type of reaction leads to the stabilization of the RuO/sub 2/. As long as the titanium has an oxidation state less than four no RuO/sub 3/ will be formed. There have been a number of suggestions that the Ru and Ti interdiffuse to form a solid solution. However, the authors' studies of the TiO-RuO/sub 2/ interface up to 600°C shows no interdiffusion of the species.

**6947 Electrode kinetics and electrolyte structure in ZnBr/sub 2/: An EXAFS study.** McBreen, J.; O'Grady, W.E.; Sayers, D.; Yang, C.Y. (Brookhaven National Lab., Dept. of Applied Science, Upton, NY 11973). pp 834 of Proceedings of the 1986 Spring meeting of the Electrochemical Society. Vol. 86.1. Pennington, NJ; The Electrochemical Society (1986). (CONF-860540—). Contract AC02-76CH00016;AS05-80ER10742.

From 169. meeting of the Electrochemical Society; Boston, MA, USA (4 May 1986).

Previous work has shown that the kinetics of zinc deposition are much faster in zinc bromide than in zinc chloride electrolytes. This has been attributed to the relative stability of the halide complex. The structure of ZnBr/sub 2/ electrolytes is an area of active research. Much of the old data on the stability constants of zinc-bromine complexes are discrepant. However, all indications are that the complexes are weak and are formed in a stepwise fashion. The structure of the complexes has not been fully elucidated. In the present study the kinetics of zinc deposition on glassy carbon from ZnBr/sub 2/ electrolytes was investigated. The effect of additions of KCl, AlCl/sub 3/, and AlBr/sub 3/ was investigated. EXAFS studies were carried out on these and other electrolytes in an attempt to correlate electrolyte structure and deposition kinetics.

**6948 Electrochemistry and photoelectrochemistry of dye-incorporated clay-modified electrode.** Kamat, P.V. (Univ. of Notre Dame, IN). *Journal of Electroanalytical Chemistry;* 163: 389-394(1984).

Thionine has been successfully incorporated in the clay films that were cast on $SnO_2$ and Pt electrodes. Results of the electrochemical and photoelectrochemical investigation of these dye-incorporated clay-modified electrodes are presented herein. 13 references, 3 figures.

## 4005 Photochemistry

*REFER ALSO TO CITATION(S) 6603, 6934, 6939, 6948*

**6949 (LBL—22100) Photofragmentation dynamics of iodohaloethanes.** Minton, T.K. (California Univ., Berkeley (USA). Dept. of Chemistry). Aug 1986. Contract AC03-76SF00098. 142p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87001725.

Detailed investigations are provided into the photofragmentation dynamics of two iodohaloethanes, $CH_2ClCH_2I$ and $CF_2BrCH_2I$, thus illustrating the methodology of these studies. The results for these molecules along with five other similar systems are summarized and some trends that have become manifest are discussed. The center-of-mass translational energy distributions of the photofragments have been derived for both the I(²P/sub 1/2/) and I(²P/sub 3/2/) dissociation channels, yielding the relative probability for each channel (which varies widely as a function of the excitation wavelength and the substituents on the iodoethane). Angular distributions of the photofragments with respect to the laser polarization indicate that primary (C-I) photodissociation proceeds via a parallel transition (i.e., the transition moment must be nearly parallel to the C-I bond) for every system studied. Finally, the energy threshold for spontaneous secondary dissociation was observed for a number of systems, enabling the determination of the reaction enthalpy for $RXI \rightarrow R + X + I$, from which the heat of formation $\Delta H/sub\ f/°(0)$ of the iodohaloethane parent can be calculated and the stability of the haloethyl radical can be inferred.

**6950 Liquid phase electron spin-echo studies: direct detection of the transverse relaxation time of photoproduced tetramethylbenzidine cation in aqueous micellar solutions of sodium dodecylsulfate.** Narayana, P.A.; Kevan, L. (Univ. of Houston, TX). *Photochemistry and Photobiology;* 37: No. 1, 105-107(1983). Contract AS05-80ER10745.

Electron spin echo detection of laser photogenerated tetramethylbenzidine cation in liquid sodium dodecylsulfate micellar solutions at room temperature is reported. The phase memory time is 180 ns which can be identified with the transverse relaxation time. Deuteration effects on the phase memory time indicate that the cation interacts more strongly with surfactant molecules than with water molecules. 13 references, 2 figures.

**6951 Intramolecular alkene cycloaddition via excited donor-acceptor complexes.** Jones, G. II; Becker, W.G.; Chiang, S. (Boston Univ., MA). *Journal of Photochemistry;* 19: 245-251(1982).

The intramolecular photoaddition of 1,4,4a,5,8,8a-hexahydro-1,4,5,8- endo,endo-dimethanonaphthalene to provide a cage isomer is reported. The internal addition of non-conjugated alkene moieties is induced on quenching the fluorescence of electron acceptors or by irradiation of ground state charge transfer (CT) complexes of the diene. Quantum efficiencies for rearrangement are generally high and even exceed 1.0 for irradiation in a polar solvent, indicative of a chain mechanism involving radicals ions. A novel dependence of quantum yield on the excitation wavelength for irradiation of CT complexes was observed and is ascribed to dissociation of the Franck-Condon CT state. The triplet sensitized isomerization which proceeds with unit quantum efficiency is also reported. The rearrangement of the electron donor diene is compared with the well-known isomerization of norbornadiene. 31 references, 2 figures, 2 tables.

## 4006 Radiation Chemistry

**6952 (CEA-R—5341) Rare oxidation states of group V metal compounds generated by radiolysis in non aqueous solvents: experimental and theoretical study. Attempts for synthesis of heterometallic complexes containing niobium and uranium or thorium.** Le Motais, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Feb 1986. 198p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE87750221.

Mononuclear and binuclear complexes of group V trivalent metals (V, Nb, Ta), coordinated with γ-picolin molecules and chlorine atoms, have been oxidized or reduced, respectively by the radical-ions $CH_2Cl_2^+$ or $CH_2CN^-$ radiolytically generated in free-oxygen dichloromethane or acetonitrile. The mechanism of these reactions have been established from kinetic, spectroscopic data and in some cases, from EPR measurements and theoretical SWXα calculations. Some preliminary results about the reaction occurring between $Cp_2Nb$-(CO)H and $Cp_2'M(CH_3)_2$ (M=U or Th) (Cp = eta$^5$ - $C_5H_5$; Cp = eta$^5$ - $(C_5(CH_3)_5)$ are also reported.

**6953 Are neutral sodium atoms produced on glass surfaces by electron bombardment?.** Pederson, L.R. (Battelle Pacific Northwest Labs., Richland, WA). *Surface Science;* **119**: L307-L313(1982). Contract AC06-76RL01830.

Recent papers have speculated that neutral sodium atoms are produced in significant quantities in glass by electron bombardment. XPS measurements on an electron-bombarded soda lime silicate glass revealed no evidence for neutral atoms at the surface or at depths up to the maximum penetration of the electron beam. 17 references, 4 figures, 2 tables.

## 4007 Radiochemistry And Nuclear Chemistry

*REFER ALSO TO CITATION(S) 6917, 7400*

**6954 (DOE/ER/40237—T2) Chemistry of gaseous lower-valent actinide halides.** Hildenbrand, D.L.; Lau, K.H. (SRI International, Menlo Park, CA (USA)). 28 May 1986. Contract AC03-85ER40237. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001655.

The objective of this program is to provide accurate thermochemical information for the uranium and thorium halide and oxyhalide systems, two of the key actinide systems, so that the basic factors underlying the chemical bonding and chemical reactivity in these systems can be elucidated in a systematic way. A complete characterization of the uranium and thorium systems will serve as a reliable base for modeling the behavior of the heavier actinides, which will be much more difficult to study because of sample size and safety restrictions. Our principal focus is on the the gaseous halides, mainly the lower-valent halides, because these molecular species largely will define the high-temperature chemistry in the nuclear applications of interest. 2 refs., 1 tab.

**6955 (IPNO-DRE—85-24) Thermodynamical properties systematic of actinides in aqueous solution.** David, F. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1985. 38p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750278.

The report contains systematics on some physicochemical properties of heavy elements, curium through lawrentium. In some cases, systematics included a comparison between lanthanide and actinide elements. First chapter deals with electronic configurations, f → d electronic transition and ionization potentials. Main properties of the metals are given: crystallographic structures, entropy and sublimation. Since, no experimental data are available for heavy elements, estimations are deduced from semi-empirical calculations or correlations. A special attention is drawn on crystallographic radii since they are basic parameters to interpret thermodynamic properties. A consistent set of data is presented for divalent, trivalent and tetravalent ions. Effect of coordination number is discussed and estimations are given for unusual oxidation states. Finally, the existence of oxidation states is discussed. Thermodynamic properties of aquo ions are presented after a description of their structure. A model of the water molecules-ion interactions is described as well as a semi-empirical expression of the enthalpy of hydration. This general expression is used to evaluate hydration enthalpies of divalent, trivalent and tetravalent ions. Entropies of aquo ions are also estimated taking into account the ion structure. At last, experimental data of the enthalpy of formation of aquo ions are presented. New evaluations of redox potentials are deduced from calorimetric and electrochemical data and entropy estimates. Then, variations of redox potentials with atomic number are compared using theoretical values for unstable oxidation states. (17 fig., 86 refs).

**6956 Organo-f-element thermochemistry. Thorium vs. uranium and ancillary ligand effects on metal-ligand bond disruption enthalpies in bis(pentamethylcyclopentaidienyl)actinide Bis(hydrocarbyls) and bis(pentamethylcyclopentadienyl)alkoxyactinide hydrides and hydrocarbyls.** Bruno, J.W.; Stecher, H.A.; Morss, L.R.; Sonnenberger, D.C.; Marks, T.J. (Argonne National Lab., IL). *Journal of the American Chemical Society;* **108**: No. 23, 7275-7280(12 Nov 1986). Contract W-31-109-ENG-38.

Thorium and uranium-ligand bond disruption enthalpies (D(M-R)) have been determined for a series of complexes of the type $Cp'_2M(R)X$, where M = Th, or U, Cp' = eta$^5$-$(CH_3)_5C_5$, R = alkyl, aryl, or hydride, and X = alkyl, chloride, or alkoxide. The thermodynamic data were obtained by anaerobic, batch-titration, solution calorimetry from the enthalpies of solution of the organic-f-element complexes in toluene and from the subsequent enthalpies of alcoholysis with tert-butyl alcohol or methanol.

**6957 New agents to detect heart disease. A report on work at the Oak Ridge National Laboratory in Tennessee.** Knapp, F.F. (Oak Ridge National Lab., TN, USA). *International Atomic Energy Agency Bulletin;* **28**: No. 2, 26-32(Sum 1986).

The fatty acids labelled with iodine-123 have a strong affinity for the heart and remain there long enough to provide a very clear image of tissue damage. To prepare the methyl-branched fatty acids a 16-step organic synthesis was developed. The mono methyl-branched fatty acid (BMIVN) and dimethyl-branched fatty acid (DMIVN) in which the iodine-123 has been stabilized by the vinyl iodide approach also have been developed and evaluated at ORNL. The positively charged cationic phosphorus and related compound in which the iodine-123 is attached, is another radiopharmaceutical that the ORNL is developing for heart imaging. The osmium-191/iridium-191 radionuclide generator for detecting heart defects in children and adults was improved. It was found that a special heat-treated activated carbon adsorbent exhibited the best properties. The useful shelf-life of this new generator has been increased to several weeks.

## 4008 Combustion, Pyrolysis, And High-temperature Chemistry

*REFER ALSO TO CITATION(S) 6812, 6813, 7242*

**6958 (N—86-28139) Behavior of fuel-lean premixed flames in a standard flammability limit tube under controlled gravity conditions. Final report, January-December 1985.** Wherley, B.L.; Strehlow, R.A. (Illinois Univ., Urbana (USA)). Jul 1986. 143p. (NASA-CR—177132; NAS—1.26:177132; AAE—86-3; UILU-ENG—86-0503). NTIS, PC A07/MF A01.

Fuel-lean flames in methane-air mixtures from 4.90 to 6.20 volume percent fuel and propane-air mixtures from 1.90 to 3.00 volume percent fuel were studied in the vicinity of the limit for a variety of gravity conditions. The limits were determined and the behavior of the flames studied for one g upward, one g downward, and zero g propagation. Photographic records of all flammability tube firings were obtained. The structure and behavior of these flames were detailed including the variations of the curvature of the flame front, the skirt length, and the occurrence of cellular instabilities with varying gravity conditions. The effect of ignition was also discussed. A survey of flame speeds as a function of mixture strength was made over a range of lean mixture compositions for each of the fuels studied. The results were presented graphically with those obtained by other researchers. The flame speed for constant fractional gravity loadings were plotted as a function of gravity loadings from 0.0 up to 2.0 g's against flame speeds extracted from the transient gravity flame histories for corresponding gravity loadings. The effects of varying gravity conditions on the extinguishment process for upward and downward propagating flames were investigated.

6959 (N—86-28378) **Diffusion flame extinction in slow convenctive flow under microgravity environment.** Chen, C.H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 16p. (NASA-TM—88799; E—3137; NAS—1.15:88799; CONF-861211—16). NTIS, PC A02/MF A01.

From American Society of Mechanical Engineers winter meeting; Anaheim, CA, USA (7 Dec 1986).

A theoretical analysis is presented to study the extinction characteristics of a diffusion flame near the leading edge of a thin fuel plate in slow, forced convective flows in a microgravity environment. The mathematical model includes two-dimensional Navier-Stokes momentum, energy and species equations with one-step overall chemical reaction using second-order finite rate Arrhenius kinetics. Radiant heat loss on the fuel plate is applied in the model as it is the dominant mechanism for flame extinguishment in the small convective flow regime. A parametric study based on the variation of convective flow velocity, which varies the Damkohler number (Da), and the surface radiant heat loss parameter (S) simultaneously, is given. An extinction limit is found in the regime of slow convective flow when the rate of radiant heat loss from fuel surface outweighs the rate of heat generation due to combustion. The transition from existent envelope flame to extinguishment consists of gradual flame contraction in the opposed flow direction together with flame temperature reduction as the convective flow velocity decreases continuously until the extinction limit is reached. A case of flame structure subjected to surface radiant heat loss is also presented and discussed.

6960 (N—86-31409, pp vp) **Fire control method and analytical model for large liquid hydrocarbon pool fires.** Fenton, D.L. Jul 1986. NTIS, PC A99/MF E03. (NASA-CR—171931; NAS—1.26:171931).

In NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1985.

The dominate parameter governing the behavior of a liquid hydrocarbon (JP-5) pool fire is wind speed. The most effective method of controlling wind speed in the vicinity of a large circular (10 m dia.) pool fire is a set of concentric screens located outside the perimeter. Because detailed behavior of the pool fire structure within one pool fire diameter is unknown, an analytical model supported by careful experiments is under development. As a first step toward this development, a regional pool fire model was constructed for the no-wind condition consisting of three zones -- liquid fuel, combustion, and plume -- where the predicted variables are mass burning rate and characteristic temperatures of the combustion and plume zones. This zone pool fire model can be modified to incorporate plume bending by wind, radiation absorption by soot particles, and a different ambient air flow entrainment rate. Results from the zone model are given for a pool diameter of 1.3 m and are found to reproduce values in the literature.

# 42 ENGINEERING

6961 (AGARD-CP—94) **Aircraft and Bearing Tribological Systems.** (Advisory Group for Aerospace Research and Development, 92 - Neuilly-sur-Seine (France)). Feb 1986. 232p. (CONF-8504278—). NTIS HC A11/MF A01.

From Aircraft and bearing tribological systems; San Antonio, TX, USA (22 Apr 1985).

Advances in aircraft gear and bearing tribology are discussed. Future trends and problems, gear and bearing materials, and lubricants are discussed.

6962 (N—86-28407) **Applications of Tethers in Space: workshop proceedings, volume 1.** Baracat, W.A. (National Aeronautics and Space Administration, Washington, DC (USA)). Jun 1986. 585p. (NASA-CP—2422-VOL-1; NAS—1.55:2422-VOL-1; CONF-8510374—Vol.1). NTIS, PC A25/MF A01.

From Workshop on applications of tethers in space; Venice, Italy (15 Oct 1985).

The complete documentation of the workshop including all addresses, panel reports, charts, and summaries are presented. This volume presents all the reports on the fundamentals of applications of tethers in space. These applications include electrodynamic interactions, transportation, gravity utilization, constellations, technology and test, and science applications.

## 4202 Facilities And Equipment

*REFER ALSO TO CITATION(S) 6497, 6688, 6908, 7217, 7628*

6963 (AD-A—171756/0/XAB) **Development of a low-noise 10K J-T refrigeration system. Technical progress report.** Little, W.A.; Edman, H.; Stewart, M.; DuBois, M.; Nasg, A. (MMR Technologies, Inc., Mountain View, CA (USA)). 15 Aug 1986. 7p. NTIS, PC A02/MF A01.

This report summarizes the work done to date, in the first 30 days on the development of a low-noise, Joule-Thomson, microminiature refrigeration system designed for 10K operation. The plan of attack for the present contract has three major parts to it: first, the development of the three-stage refrigerator; second, the development of a suitable compressor to provide the gases, and thirdly, the development of an effective gas-cleansing system.

6964 (ERNO—71-AHF/2) **Advanced heating facilities. Development of demonstration models. Final Report.** Schawer, J.; Brost, O.; Blersch, G.; Ranke, S.; Becker, R. (ERNO Raumfahrttechnik G.m.b.H., Bremen (Germany, F.R.)). Aug 1985. 158p. (ESA-CR(P)—2156). NTIS, PC A08/MF A01.

From Workshop on electron cyclotron emission and electron cyclotron heating and gyrotron user/developer meeting; San Diego, CA, USA (9 Nov 1985).

Electron beam and heat pipe technique furnaces for space-borne microgravity experiments were assessed. Testing of demonstration model furnaces clearly shows the advantages of the heat pipe principle for an isothermal furnace. Isothermality of the whole furnace working space can be provided without additional heaters for compensation of the working space end heat losses. Temperature stability during long-time furnace operation can be achieved by using a variable conductance heat pipe (VCHP) with gas pressure feedback-control. The VCHP principle with gas pressure measurement provides a viable method to improve the temperature measurement accuracy, for absolute temperature measurement, and provides long-time accuracy of the temperature measurement. The furnace can be operated at least in a temperature range of 900 to 1500 C.

6965 (LA/Sub—D3866F-1) **Vacuum switch recovery investigation. Final report, September 2-November 15, 1986.** Dougal, R.A. (South Carolina Univ., Columbia (USA). Dept. of Electrical and Computer Engineering). 1986. Contract W-7405-ENG-36. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002308.

Metal vapor densities have been studied during the post-current-zero phase of a vacuum switching gap to determine whether inconsistent recovery performance might be attributable to higher than expected vapor densities. In addition, comparisons were made between the vapor density after current zero and the total energy dissipated in the switch during the conduction phase to determine whether the two were correlated. Laser-induced fluorescence (LIF) measurements of metal vapor in the gap after current conduction seem to indicate that the vapor density at the observation point near the center of the gap varied considerably on a shot to shot basis, that the vapor density was not well correlated with the total energy dissipated in the switch during the current pulse, that the vapor remained in the gap longer than expected, and that the vapor density displayed a rather strong spatial structure. However, the experimental conditions were not ideal for making quantitative measurements, and no absolute calibration standard can be applied to the data.

6966 (LA-UR—86-3562) **Future of remote handling.** Grisham, D.L.; Lambert, J.E. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-861102—25). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001966.

From American Nuclear Society and Atomic Industrial Forum joint meeting; Washington, DC, USA (16 Nov 1986).

The field of remote handling started in the late 1940's and early 1950's with the invention of mechanical master-slave and electromechanical manipulators. That field now consists of three major divisions: (1) conventional remote handling in fixed facilities with shielding windows and mechanical manipulators; (2) large area remote handling using portable equipment, electric master-slave manipulators, and television for viewing; and (3) the field of robotics which is beginning to be applied to repetitive operations on toxic and dangerous materials. All three divisions will continue to develop and evolve over the next decade.

6967 (N—86-29148) **Non-Newtonian heat and mass transport of He 2 in porous media used for vapor-liquid phase separation. Ph.D. Thesis.** Yuan, S.W.K. (California Univ., Los Angeles (USA)). 1985. 222p. (NASA-CR—177075; NAS—1.26:177075). NTIS, PC A10/MF A01.

This investigation of vapor-liquid phase separation (VLPS) of He 2 is related to long-term storage of cryogenic liquid. The VLPS system utilizes porous plugs in order to generate thermomechanical (thermo-osmotic) force which in turn prevents liquid from flowing out of the cryo-vessel (e.g., Infrared Astronomical Satellite). An apparatus was built and VLPS data were collected for a 2 and a 10 micrometer sintered stainless steel plug and a 5 to 15 micrometer sintered bronze plug. The VLPS data obtained at high temperature were in the nonlinear turbulent regime. At low temperature, the Stokes regime was approached. A turbulent flow model was developed, which provides a phenomenological description of the VLPS data. According to the model, most of the phase separation data are in the turbulent regime. The model is based on concepts of the Gorter-Mellink transport involving the mutual friction known from the zero net mass flow (ZNMF) studies. The latter had to be modified to obtain agreement with the present experimental VLPS evidence. In contrast to the well-known ZNMF mode, the VLPS results require a geometry dependent constant (Gorter-Mellink constant). A theoretical interpretation of the phenomenological equation for the VLPS data obtained, is based on modelling of the dynamics of quantized vortices proposed by Vinen. In extending Vinen's model to the VLPS transport of He 2 in porous media, a correlation between the K*(GM) and K(p) was obtained which permits an interpretation of the present findings. As K(p) is crucial, various methods were introduced to measure the permeability of the porous media at low temperatures. Good agreement was found between the room temperature and the low temperature K(p)-value of the plugs.

6968 (N—86-30160) **Instability in Rotating Machinery.** (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Dec 1985. 458p. (NASA-CP—2409; E—2652; NAS—1.55:2409). NTIS, PC A21/MF A01.

From Instability in Rotating Machinery; Carson City, NV, USA (10 Jun 1985).

The proceedings contain 45 papers on a wide range of subjects including flow generated instabilities in fluid flow machines, cracked shaft detection, case histories of instability phenomena in compressors, turbines, and pumps, vibration control in turbomachinery (including antiswirl techniques), and the simulation and estimation of destabilizing forces in rotating machines. The symposium was held to serve as an update on the understanding and control of rotating machinery instability problems.

6969 (N—86-30160, pp vp) **Full load shop testing of 18,000-hp gas turbine driven centrifugal compressor for offshore platform service: Evaluation of rotor dynamics performance.** Kirk, R.G.; Simpson, M. (Ingersoll-Rand Co. Ltd., Wythenshawe, England). Dec 1985. NTIS, PC A21/MF A01. (NASA-CP—2409; E—2652; NAS—1.55:2409).

From Instability in Rotating Machinery; Carson City, NV, USA (10 Jun 1985).

The results for in-plant full load testing of a 13.4 MW (18000 HP) gas turbine driven centrifugal compressor are presented and compared to analytical predictions of compressor rotor stability. Unique problems from both oil seals and labyrinth gas seals were encountered during the testing. The successful resolution of these problems are summarized.

6970 (N—86-30160, pp vp) **Aerodynamic instability: a case history.** Eisenmann, R.C. Dec 1985. NTIS, PC A21/MF A01. (NASA-CP—2409; E—2652; NAS—1.55:2409).

From Instability in Rotating Machinery; Carson City, NV, USA (10 Jun 1985).

The identification, diagnosis, and final correction of complex machinery malfunctions typically require the correlation of many parameters such as mechanical construction, process influence, maintenance history, and vibration response characteristics. The progression is reviewed of field testing, diagnosis, and final correction of a specific machinery instability problem. The case history presented addresses a unique low frequency instability problem on a high pressure barrel compressor. The malfunction was eventually diagnosed as a fluidic mechanism that manifested as an aerodynamic disturbance to the rotor assembly.

6971 (N—86-30517) **Superconducting tunnel junction receiver for millimeter-wave astronomy.** Pan, S.K.; Kerr, A.R. (National Aeronautics and Space Administration, New York (USA). Goddard Inst. for Space Studies). Jul 1986. 243p. (NASA-TM—87792; NAS—1.15:87792). NTIS, PC A11/MF A01.

The development and construction of an ultralow noise heterodyne receiver for millimeter wave astronomy is described along with its use for 115.3 GHz Co line observations. The receiver uses a Superconductor-Insulator-Superconductor (SIS) quasiparticle tunnel junction mixer to convert the millimeter wave signal to a microwave intermediate frequency. Experiments aimed at quantitative verification of J. R. Tucker's quantum mixer theory are studied, to see whether it could be used as the basis for the design of a practical receiver. The experimental results were in excellent agreement with the theory, assuming the three frequency approximation. Infinite available gain and negative output resistance were observed for the first time, nonclassical effects which are not seen in conventional diode mixers. Using Tucker's theory, an SIS receiver was then designed and constructed. At 115 GHz, the single sideband receiver noise temperature is 83K, the lowest ever reported in this frequency range. A CO survey toward Cygnus-X region, using this SIS receiver on the Columbia-GISS 4 ft. telescope, is also described.

6972 (N—86-30554) **Dynamics insulation systems.** Chen, W.E.W.; Hepler, W.A.; Yuan, S.W.K.; Frederking, T.H.K. (California Univ., Los Angeles (USA)). Oct 1985. 38p. (NASA-CR—177026; NAS—1.26:177026; UCLA-ENG—8532). NTIS, PC A03/MF A01.

Advanced dynamic insulation systems were analyzed from a thermodynamic point of view. A particular performance measure is proposed in order to characterize various insulations in a unique manner. This measure is related to a base quantity, the refrigeration power ratio. The latter is the minimum refrigeration power, for a particular dynamic insulation limit, to the actual reliquefaction power associated with cryoliquid boiloff. This ratio serves as reference quantity which is approximately constant for a specific ductless insulation at a chosen normal boiling point. Each real container with support structure, vent tube, and other transverse components requires a larger refrigeration power. The ratio of the actual experimental power to the theoretical value of the support-less system is a suitable measure of the entire insulation performance as far as parasitic heat leakage is concerned. The present characterization is illustrated using simple thermodynamic system examples including experiments with liquid nitrogen. Numerical values are presented and a comparison with liquid helium is given.

6973 (N—86-30555) **High accuracy heat capacity measurements through the lambda transition of helium with very high temperature resolution. Final report, 1 September 1980-31 August 1983.** Fairbanks, W.M.; Lipa, J.A. (Stanford Univ., CA (USA)). Apr 1984. 51p. (NASA-CR—177037; NAS—1.26:177037). NTIS, PC A04/MF A01.

A measurement of the heat capacity singularity of helium at the lambda transition was performed with the aim of improving tests of the Renormalization Group (RG) predictions for the static thermodynamic behavior near the singularity. The goal was to approach as closely as possible to the lambda-point while making heat

capacity measurements of high accuracy. To do this, a new temperature sensor capable of unprecedented resolution near the lambda-point, and two thermal control systems were used. A short description of the theoretical background and motivation is given. The initial apparatus and results are also described.

6974 (UCRL—50007-85, pp 10-13) **Effect of organic vapor mixtures on the service life of respirator cartridges.** Swearengen, P.M.; Weaver, S.C. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Pairs of MSA respirator cartridges were challenged with two compounds, isopropyl alcohol and methyl ethyl ketone, to study the effects of organic vapor mixtures on respirator cartridge performance. Each cartridge was challenged at three concentrations: low concentrations of the single compounds, a mixture of the two compounds, and high concentrations of the single compound. Each experiment was conducted at 20% and at 85% relative humidity. One and 10% breakthrough times were observed in every case; it was found that the breakthrough times for the mixture agreed with the single high-concentration challenge. The experimental data were matched to a theoretical model derived from modified Wheeler-Robell equations and showed close correlations between adsorption rate constants for the mixture and for the individual compounds. Based on these first experiments, its felt that an accurate mathematical model for determining the kinetics of organic vapor mixtures is possible. Further experiments are planned to verify this.

6975 (UCRL—50007-85, pp 24-27) **Fabricating micro air filters using lithographic techniques.** Bergman, W.; Ciarlo, D. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

A method for manufacturing very precise micro air filters was developed using lithographic techniques, similar to the way in which computer chips are made. These small filters are readily used for filtration studies and experiments. One of the new techniques uses gold fibers formed by electroplating gold on a template; the other technique uses boron diffusion to define the fibers. While these two methods show a great deal of promise, the major drawback is that the fibers themselves are not round, but rectangular (in the case of the gold fibers) or elliptical (in the case of the boron fibers).

6976 (UCRL—50007-85, pp 28-33) **Development of a high-efficiency, high-performance air filter medium.** Bergman, W.; Biermann, A.H.; Sawyer, S.R.; Martin, O.T. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

A unique high-efficiency particulate air (HEPA) filter medium has been developed for applications in high temperature and high pressure environments. This filter medium is a composite made from quartz and stainless-steel fibers that have been sintered together. The composite medium has the same efficiency and pressure drop as standard HEPA glass media, but has four times the tensile strength and can operate continuously at temperatures up to 550°C. In a conventional HEPA, the binder burns out above 250°C, and the medium loses its strength; the composite filter medium has no comparable loss of strength even at 550°C.

6977 (UCRL—50007-85, pp 43-47) **New test methods for ultra-low penetration aerosol (ULPA) filters.** Bergman, W.; Biermann, A.H.; Sawyer, S.R. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Ultra-Low Penetration Aerosol (ULPA) filters have many uses in clean-room applications. However, existing ULPA test methods are not adequate to measure the filter efficiency because the filter becomes loaded to capacity before a meaningful measurement can be made. A new test method was developed that uses particle spectrometers and a sampling bag downstream of the filter. By capturing all of the air downstream of the filter rather than just a small sample, the bag allows for much shorter sampling times. This eliminates the filter-loading problems experienced with the previous test method.

6978 (UCRL—50007-85, pp 55-58) **Thermal degradation of welding blankets.** Lipska-Quinn, A.E.; Priante, S.J. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

The thermal-degradation mode of a number of non-asbestos welding blankets was investigated. Twenty-five samples representing the products of major blanket distributors were subjected to thermogravimetric analysis in air to determine the onset and the extent of thermal degradation. Samples with the least amount of weight loss were also studied for production of toxic products during thermal degradation (carbon monoxide, carbon dioxide, hydrogen cyanide, hydrogen chloride, and formaldehyde). The most thermally stable blanket exhibiting the least amount of toxic-product formation during degradation was subjected to a large-scale test. The sample for the large-scale test was 3- x 3-ft in size, exposed to 3500°C from an oxyacetylene torch and tested for toxic products approximately one foot away from the cloth. Results of the study indicate that unless welding blankets are composed of silica cloth, they will lose a considerable amount of weight when exposed to temperatures as low as 300°C and will form substantial amounts of toxic products. Blankets made of silica cloth are extremely resistant to high temperatures, produce minimal amounts of toxic products, and are, therefore, the best substitute for the previously used asbestos blankets.

6979 (UCRL—50007-85, pp 59-64) **Fire endurance of sprinklered glass walls.** Beason, D. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

The National Fire Protection Association (NFPA) code allows the use of tempered glass walls as fire and smoke barriers in the construction of atriums. The LLNL Fire Science Group conducted tests to determine if fires would be likely to shatter these glass barriers and allow smoke and flame penetration into adjoining rooms. A large (250 kW) and a small (40 kW) fire source were used to test tempered glass, ordinary plate glass, and laminated safety glass. While the tempered glass allowed by the NFPA code showed no damage from the large fire which was sufficient to initiate the room sprinkler, the glass did shatter when directly exposed to the 40-kW fire. The plate glass cracked with the 250-kW fire and allowed smoke penetration. The best candidate was the laminated safety glass, which cracked upon exposure to the 250-kW fire, but maintained its integrity and did not allow the passage of smoke or flames.

6980 (UCRL—50007-85, pp 65-68) **Sensitivity of fire and smoke detectors to environmental conditions: RF and microwave exposure.** Staggs, K.J. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Certain extreme environmental conditions can affect the performance of fire and smoke detectors, either with false alarms or with decreased sensitivity. The types and placement of smoke detectors in areas of extreme environmental conditions at the Lawrence Livermore National Laboratory were studied. To determine the effect of exposure to radiofrequency or microwaves, some types of smoke detectors were tested with a small transmitter and a microwave generator. With the low power levels available to the test instruments, no change in the smoke detector performance was found.

6981 (UCRL—50007-85, pp 69-78) **Shock hazards resulting from the inadvertent release of water from fire-protection sprinkler systems.** Alvares, N.J.; Staggs, K.J. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

The inadvertent release of water from fire-protection sprinkler systems could increase the risk of shock to workers in areas where high-voltage electrical equipment is in operation. Two types of experiments were conducted to survey the extent of this risk: (1) to assess electrical conduction through water films on floor surfaces such as could result from spinkler release, and (2) to define the potential of electrical discharge from surfaces of high electrical potential to a person in the area. For the latter series of tests, water-spray distributions and concentrations, and a grounded resistance probe of the same average resistivity as the human body were selected. The findings show that water film conductivity provides the most direct electrical coupling between high-potential conductors and ground. The pattern of the voltage gradient indicates significant importance of position and proximity of electrodes to the ground point. Water-spray discharge studies show no increase in current flow between the high-voltage grid and the grounded electrode, which is not dependent on water conductivity.

6982 (UCRL—50007-85, pp 100-105) **Calculations to assess nuclear criticality safety: power-history calculations of nuclear excursions.** Lutz, H.F. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

A set of four computer codes that are useful in many aspects of criticality safety practice are described. These codes will be made available to run on small personal computers for comparison with the results of more comprehensive calculations running on large mainframe machines. Calculations using the smaller codes are easier and less expensive to run, and also allow field calculations. The first of the four Nuclear Criticality Safety Assessment Codes - for calculating the power histories of nuclear excursions - has been completed. The development of the point-reactor model, a lumped-parameter model that allows one to exploit several useful approximations is described. The assumptions made, the means of obtaining effective values of kinetic parameters in the chain-reacting system are described, and the range of validity of the model is given. Refinements of the point-reactor model allow one to take into account reactivity feedback and yield-enhancing mechanisms. The second code, criticality calculations of arrays of fissile material, is currently being documented; the other two codes - criticality calculations of single units of fissile material, and consequence models - will be produced at six-month intervals. Copies of the first code and its documentation are available.

6983 (UCRL—50007-85, pp 106-112) **Experimental study of neutron noise with criticality safety applications in mind.** Barnett, C.S. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

In order to explore the feasibility of developing a criticality warning system, the statistics of detected neutrons that leaked from four subcritical reflected enriched-uranium assemblies were studied. Three possible signatures that might be used to discriminate among assemblies of various multiplications were studied. They are (1) variance-to-mean (V/M) ratio of the counts in a time bin, (2) covariance-to-mean (C/M) ratio of the counts in a common time bin from two different detectors, and (3) covariance-to-mean ratio of the counts from a single detector in two adjacent time bins of equal length, which is called the serial covariance-to-mean (SC/M) ratio. The performances of the three discriminators were not greatly different, but in general SC/M was more effective than V/M, which in turn was more effective than C/M. The noise-analysis techniques performed well enough in deeply subcritical situations to deserve testing in an applications environment. They have a good chance of detecting potentially dangerous changes in reactivity. One can expect the sharpest results when comparing two records, one taken in the past under circumstances known to be normal and one taken at present to search for a change.

6984 (UCRL—50007-85, pp 113-117) **LLNL risk assessment of competing construction projects.** Morse, J.L.; Bloedorn, J.J.; Trolan, R.T. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Each year LLNL reviews all facility and utility upgrade projects to determine their relative ranking in terms of safety benefit vs cost. This process begins when a team of health and safety professionals screens the proposed upgrade projects. A personal computer is used to record, display, and print risk data about each competing project. This information, including a computer-generated cost-benefit graph, assists line management to reach decisions concerning the relative merit of each project. The spreadsheet formatting used to perform the risk scoring and the cost-benefit analysis is described.

6985 **Self-contained hot-hollow cathode gun source assembly.** Zeren, J.D. (to Dept. of Energy, Washington, DC). US Patent 4,620,081. 28 Oct 1986. Filed date 3 Aug 1984. v.p.

This patent describes a self-contained hot-hollow cathode gun source assembly, for use in a vacuum chamber, comprising: a crucible block having opposed and spaced upper and lower surfaces, first and second sides, front and rear portions, a coolant channel for conducting a coolant through the block. A coolant input means supplies a coolant to the channel, and a coolant output means removes a coolant from the channel; the upper surface including means for holding a deposition material, and a hole extending between the upper and lower surfaces, the hole being adjacent the front portion, the means for holding being between the hole and the rear portion; first and second pole plates affixed to the first and second sides, respectively, of the block, each of the plates including: an upper edge adjacent the upper surface of the block; a lower edge extending below the lower surface of the block; and a plate coolant channel connected at one end to the block coolant channel and at an opposite end to one end, respectively, of first and second tubular dielectric connectors.

6986 **Design of a superconducting alternator for space-based power generation.** Kirtley, J.L. Jr.; McCabe, S.J.; Dodge, R.E. Jr.; Coomes, E.P. (Pacific Northwest Lab., Richland, WA 99352). pp 1869-1874 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The superconducting alternator has received considerable international attention over the last decade, with active programs to develop commercial units underway worldwide. Projected gains in efficiency and potential reductions in mass and construction costs have fueled superconducting alternator research. Although current research is focused on developing electric machines to supplant existing conventional alternators, the high power-density of the superconducting alternator makes it an attractive choice for generating electricity in space. This paper presents the results of a study to assess the feasibility of using a superconducting alternator for space power generation, and to develop a preliminary machine design. The preliminary design study examined a low power (20 MW) machine and a higher power (200 MW) machine.

## 4203 Lasers

*REFER ALSO TO CITATION(S) 6929, 7033, 7034, 7036, 7176, 7235*

6987 **(AD-A—171823/8/XAB) Investigation of single-crystal silicates for blue tunable lasers. Quarterly report no. 2, 1 December 1985-28 February 1986.** Belt, R.F.; Catalano, J.A. (Litton Systems, Inc., Morris Plains, NJ (USA). Airtron Div.). Jun 1986. 29p. NTIS, PC A03/MF A01.

The single-crystal growth of rare earth silicates was investigated for the purpose of tunable-laser hosts. Silicates of the type $R_2SiO_5$, where R = La, Gd, Y, were prepared from stoichiometric melts and doped with $Ce^{3+}$ activators. Seed crystals were obtained from crystallized melt sections or by growth on an iridium wire. Cathodoluminescence experiments on both powders and single crystals showed wavelength shifts with different rare earth ions. The Gd, Y, and mixed crystals of Gd-Y silicates gave good bright emission with $Ce^{3+}$. The emission is broad band and covers the wavelength range of 370-525 micron. The peak emission can be

centered near 450-460 micron by other compositions. Larger single crystals for laser hosts are under development.

6988 **(AD-A—171953/3/XAB) Free-electron lasers. Final technical report, 15 February 1984-29 February 1985.** Colson, W.B.; Sessler, A.M. (California Univ., Santa Barbara (USA). Quantum Inst.). 1985. 32p. NTIS, PC A03/MF A01.

Published in Annual Review of Nuclear and Particle Sciences, Vol. 35, 25-54, 1985.

This paper reviews the experimental and theoretical development of free-electron lasers. There is a review of types of accelerators driving FEL, the history of FELS, and the prospects for the future.

6989 **(AD-A—172022/6/XAB) Luminescent characteristics study of Mather-type dense plasma focus and applications to short-wavelength optical pumping. Final technical report, 1 May 1984-30 September 1985.** Kim, K.K. (Illinois Univ., Urbana (USA). Charged Particle Research Lab.). Jun 1986. 37p. (CPRL—2-86). NTIS, PC A03/MF A01.

A Mather-type dense plasma focus (MDPF) system was designed, built, and tested specifically to study its luminescent characteristics and to assess its potential as a new light source of high-energy, short-wavelength lasers. The luminescence study of MDPF showed that the conversion efficiency from the electrical input to the optical output energies is at least 50%, up to the time the plasma compression is complete. Using the system, for the first time as an optical pump, laser activities were successfully obtained from a variety of liquid organic dyes. Diagnostic capabilities included an optical multichannel analyzer system complete with a computer control, a nitrogen-pumped tunable dye-laser system, a high-speed streak/framing camera, a digital laser energy meter, voltage and current probes, and a computer-based data-acquisition system.

6990 **(LA-UR—86-3444) Recent theoretical results for an rf-linac-driven XUV free-electron laser.** Goldstein, J.C.; McVey, B.D. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 26p. (CONF-8609131—7). NTIS, PC A03/MF A01; GPO Dep. File Number DE87001958.

From 8. international free electron laser conference; Glasgow, UK (1 Sep 1986).

New theoretical results are presented for the characteristics and performance of an rf-linac-driven XUV free-electron laser. These results fall into two categories: (1) the dependence of the small-signal gain upon the transverse phase-space distribution of the electron beam and the geometry of the optical resonator; and (2) the optical spectral bandwidth. Within (1) we discuss, and present 3-d numerical calculations of, the small-signal gains expected for different phase-space distributions. The gain also varies substantially with the Rayleigh range of the optical resonator. Thus, for maximum small-signal gain, the design of the resonator is coupled to the electron beam characteristics. Within (2), we discuss conditions under which there is a spectral broadening of the optical pulse due to the development of sidebands. The basis of these studies are 1-d finite pulse, and 3-d periodic boundary condition, numerical computer codes.

6991 **(N—86-28399) Direct solar-pumped iodine laser amplifier. Semiannual progress report, 1 October 1985-30 March 1986.** Han, K.S. (Hampton Inst., VA (USA)). Mar 1986. 61p. (NASA-CR—177238; NAS—1.26:177238). NTIS, PC A04/MF A01.

During this period the parametric studies of the iodine laser oscillator pumped by a Vortek simulator were carried out before amplifier studies. The amplifier studies are postponed to the extended period after completing the parametric studies. In addition, the kinetic modeling of a solar-pumped iodine laser amplifier, and the experimental work for a solar pumped dye laser amplifier are in progress. This report contains three parts: (1) a 10 W CW iodine laser pumped by a Vortek solar simulator; (2) kinetic modeling to predict the time to lasing threshold, lasing time, and energy output of solar-pumped iodine laser; and (3) the study of the dye laser amplifier pumped by a Tamarack solar simulator.

6992 **(N—86-30136) NASA Lidar system support and MOPA technology demonstration. Final report.** Laughman, L.M.; Capuano, B.; Wayne, R.J. (CLS Laser Systems, Inc., South Windsor, CT (USA)). Aug 1986. 88p. (NASA-CR—178144; NAS—1.26:178144). NTIS, PC A05/MF A01.

A series of lidar design and technology demonstration tasks in support of a $CO_2$ lidar program is discussed. The first of these tasks is discussed in Section VI of this report under the heading of NASA Optical Lidar Design and it consists of detailed recommendations for the layout of a $CO_2$ Doppler lidar incorporating then existing NASA optical components and mounts. The second phase of this work consisted of the design, development, and delivery to NASA of a novel acousto-optic laser frequency stabilization system for use with the existing NASA ring laser transmitter. The second major task in this program encompasses the design and experimental demonstration of a master oscillator-power amplifier (MOPA) laser transmitter utilizing a commercially available laser as the amplifier. The MOPA design including the low chirp master oscillator is discussed in detail. Experimental results are given for one, two and three pass amplification. The report includes operating procedures for the MOPA system.

6993 **Design and characterization of a high average power slab YAG laser.** Abrecht, G.F.; Eggleston, J.M.; Ewing, J.J. (Lawrence Livermore National Lab., Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **QE-22**: No. 11, 2099-2106(Nov 1986).

The detailed design and characterization of a zigzag optical path laser with a 0.6 X 2 X 15 cm Nd: YAG slab is described. Beam distortions arising from nonuniform pumping of the slab and from various end effects are diagnosed, and the implementation of corrective measures is explained. The authors report on the device performance of the free running oscillator with 70 W output at 1.06 μm and the amplifier with parasitic suppression in which a small signal amplification of 45X was achieved.

6994 **(UCRL-Trans—12135) Electronic compensating calorimetry as a method of measuring quantum efficiencies and differentiating various nonradiant decay processes in laser crystals.** Stark, E. (Lawrence Livermore National Lab., CA (USA); Hamburg Univ. (Germany, F.R.). Fachbereich Physik). Oct 1986. Contract W-7405-ENG-48. Translation of German Dissertation, 1983. 145p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87002425.

In developing new solid-state laser systems, it is very important to measure nonradiant decay processes, because these have an influence on the pumping power threshold. It has been possible with the help of a newly developed electronic compensating calorimeter to measure quantum efficiencies in stoichiometric Nd laser crystals and to separate the influences of cross relaxation (including the concentration dependence and temperature dependence at high temperatures), multiphonon emission, Auger recombination and reabsorption in the nonradiant processes. Surprisingly, in the attempt to find a relationship between crystal growing temperature, quantum efficiency and lifetime, it was found that lifetime values published so far have been as much as 25% too high due to reabsorption on tau and eta was therefore investigated experimentally and theoretically. It was demonstrated that the influence of OH defects is negligible. This evidence is provided by IR absorption spectra on the one hand and also with the help of a high-speed multichannel analyzer (50 nsec time resolution) which is also newly developed and makes it possible to investigate the energy transfer from Nd to vibrations due to the water of crystallization. This transfer depends greatly on the temperature in contrast with nonradiant decay in pentaphosphates. In contrast with the previous prevailing opinion, it was found that $Nd^{3+}$ also fluoresces in compounds that contain water of crystallization, although with a lifetime of only a few hundred nsec. These fluorescence measurements also show that Nd ions at interlattice sites have decay times that vary greatly due to their shifted energy levels. The question of the influence of the crystal growing temperature on the Nd defect concentration and thus on the cross relaxation rate is discussed. 123 refs., 61 figs.

6995 **Status of the Aurora laser system: Angular-multiplexed multikilojoule krypton fluoride prototype for inertial fusion.** Rosocha, L.A.; Goldstone, P.D.; Kristal, R. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM 87545). pp 256 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

In this presentation, the authors report on the present status of the Aurora system including: The operation of the final stage 1-X 1-m laser at the 10-kJ level; the generation of 5-ns pulses by the front end; integration of the front end, multiplexer, amplifiers, and the extraction of long-pulse energy from the amplifier chain. Progress on the design and construction of the demultiplexer are also reported.

6996 **Design of intensity-limited dye laser amplifiers.** Peterson, O.G.; Figueira, J.F.; Jensen, C.C.; Hyer, R.C. (Los Alamos National Lab., Chemistry Div., Los Alamos, NM 87545). pp 102 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Dye laser amplifiers have been analyzed and design criteria determined for operating these devices in conditions of limited output intensity. All practical laser systems are ultimately limited by damage considerations, specifically radiation-induced damage to the active laser media, containment windows, or output surfaces. In dye lasers this is of particular concern since the molecular saturation intensity is very high, of the order of a fraction to several megawatts per square centimeter. Hence efficient power extraction often requires operation very near the threahold of optical damage for the system optical components so it is necessary to develop designs that are compatible with these limitations.

6997 **Operation of a modular long-gain-length inductively stabilized excimer laser.** Sze, R.C.; Maloney, M. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM 87545). pp 142 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Previously, a double-headed inductively stabilized device named the V-8 laser (two separate discharges with gas flow connected in series) was operated and shown to have improved characteristics regarding pulse repetition rate per unit gas flow compared with more conventional avalanche discharge devices. With this device the authors showed near kilohertz operation for long times with very minimal gas flow. A new inductively stabilized device named the Stablex laser incorporates a modular design that allows length scaling in multiples of a fundamental unit of length to provide flexibility in tailoring the laser to specific applications. Initial discharge areas is 1 X 1 cm/sup 2/ with the final configuration calling for a 2-cm gap spacing. Low-pulse-repetition-rate tests on a four-model device show XeCl output energies at 175 mJ promising ultimate performance at the 400-W level at 1-kHz prf.

6998 **Free-running modes for gain-guided diode laser arrays.** Hadley, G.R.; Hohimer, J.P.; Owyoung, A. (Sandia National Labs., Advanced Laser Technology, Albuquerque, NM 87185). pp 126 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

The authors present numerical calculations for the free-running modes of a five-stripe gain-guided diode laser array operating near threshold. The results of these calculations suggest that gain-guided arrays are more appropriately modeled as broad-area devices with gain perturbations. In particular, the calculations have produced some modes which appear to be vaguely related to supermodes and other modes (of orders of >5) which bear no clear relationship to supermodes. These latter modes have twin-lobed far-field patterns whose angular separation is greater than that of the highest-order supermode. Such patterns are a direct result of the phase front curvature which is unique to gain-guided diode lasers. The set of modes for gain-guided arrays may, therefore, is approximately viewed as composed of pairs of plane waves of opposite phase front tilt whose longitudinal propagation constants satisfy the Fabry-Perot condition. This potentially infinite set of modes is rendered finite by the fact that the near-field maxima of certain modes optimally overlap the gain stripes and thus experience higher modal gains. Modes which appear similar to the ones described here have recently been observed in the laboratory.

6999 **E-beam sustained discharge KrF lasers revisited: The promise of higher efficiency.** Kushner, M.J.; Ewing, J.J.; Salesky, E.T. (Spectra Technology, 2755 Northup Way, Bellevue, WA 98004). pp 9 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The authors found that the sudden increase in photo-detachment of F/sup -/ which occurs at the onset of laser oscillation is a sufficiently large source of electrons that an ionization instability can result. The probability for onset of ionization instabilities by photo-detachment and multi-step ionization can be lessened by careful design of the discharge circuit. The impedance of the PFN should be high enough that the discharge is current limited.

7000 **Nuclear-pumped laser studies.** Hays, G.N.; McArthur, D.A.; Neal, D.A.; Pickard, P.S.; Rice, J.K. (Sandia National Labs., Albuquerque, NM 87185). pp 29 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—). Contract AC04-76DP00789.

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Recent results from kinetics studies include the measurement of gain near 351 nm in gas mixtures containing Xe, NF/sub 3/, and a rare gas. Sandia's fast-pulse reactor facility (SPR III) was used for these experiments, in which a cell containing the gas mixtures is irradiated with thermalized neutrons within the reactor's hollow central core. Energy deposition in the gas occurs through the interaction of energetic charged particles produced by neutron-induced fission events. The authors examined two pumping modes. One mode uses /sup 3/He as the rare gas, where charged particles from the /sup 3/He(n,p)/sup 3/H reaction excite the medium. Another mode uses fission fragments from /sup 235/U, which is coated on thin-walled ceramic tubes within the cell, as the source of excitation. Parametric studies of gain with changes in gas mixture and pumping power is presented.

7001 **Use of argon in imploding plasma-driven soft x-ray lasers.** Hussey, T.W.; Matzen, M.K.; McGuire, E.J.; Dukart, R.J. (Sandia National Labs.). pp 87 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The use of a cylindrically imploded, gas puff Z-pinch to create a photoionization-pumped soft x-ray laser is currently under study at Sandia National Laboratories. Present designs involve a small radius, hollow, cylindrical straw of either low-Z foam or solid density polystyrene against which the imploding gas puff stagnates. The cylinder is coated on the inside with a thin layer of copper which blows radially inward to fill the center of the cylinder with plasma at more or less uniform density. This central plasma, which is shock-isolated from the nonuniformities of the imploding gas puff by the inertia of the cylinder, will be the lasant. The outer surface of the cylinder is coated with a thin "converter" layer of aluminum, which is heated abruptly as it is struck by the imploding gas puff. The hydrogen-like lines from this aluminum plasma ionize the neon-like copper to the flourine-like state. This subsequently recombines to excited neon-like states creating an inversion on the 3p-3s transitions. Most of the authors' experimental work has used neon as the puff gas, because it gives such large k-line yields. They find from the calculations, however, that argon, though it has a relatively small k-line yield of its own, couples fa-

vorably with the aluminum, delivering a somewhat higher flux of pump radiation to the lasant. In this presentation the authors consider optimization of x-ray laser target designs using argon as the imploding gas puff.

7002 **Demonstration of a soft x-ray laser.** Eckart, M.J.; Rosen, M.D.; Matthews, D.L.; Hagelstein, P.; Ceglio, N.M.; Medecki, H.; McGowan, B.; Terebes, J.; Campbell, E.M. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 152 of Conference record of the 1985 IEEE conference on lasers and electro-optics. Piscataway, NJ; IEEE Service Center (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

Recent experiments conducted with the multiterrawatt Novette laser have demonstrated substantial amplification of soft x-rays in laser-produced plasmas. Gains at wavelengths of 206 and 209 A in neonlike selenium and at 153 A in neonlike yttrium have been observed.

7003 **Studies of stokes generation by a diffraction-limited broadband XeF pump laser.** Telle, J.; Wenzel, R. (Los Alamos National Lab., Chemistry Div., Los Alamos, NM 87545). pp 86 of Conference record of the 1985 IEEE conference on lasers and electro-optics. Piscataway, NJ; IEEE Service Center (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

High-efficiency conversion of excimer laser radiation to Stokes radiation in a single-pass Raman cell using a long-focus pumping geometry has been previously reported. The authors report here a study of the coherence properties vs efficiency of Stokes beams generated with a diffraction-limited XeF pump laser and long-focus geometry. The study, which was carried out to provide base line data for computer modeling of stimulated Raman scattering, reveals strikingly different behavior from the XeCl result. A single transverse mode oscillator beam was triple-passed through an amplifier, apertured to a diameter of 4mm, and focused with a 2-m lens to provide the f/500 pump beam. The intensity profile immediately after the aperture was radially symmetric and maximum at the center. The spot size at focus was diffraction limited. The pulse length was ≈20nsec (FWHM). The oscillator was free running and, therefore, emitted on two lines separated by ≈160cm/sup -1/.

7004 **Laser-induced damage to thin films and graded-index surfaces.** Lowdermilk, W.H. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 140 of Conference record of the 1985 IEEE conference on lasers and electro-optics. Piscataway, NJ; IEEE Service Center (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

This paper reviews laser-induced damage to dielectric thin-film antireflective (AR) and highly reflective (HR) coatings as well as gradient-index antireflectives surfaces for pulsed lasers with wavelengths in the range from 248 nm (KrF laser) to 1060 nm (Nd:glass laser).

## 4204 Heat Transfer And Fluid Flow

*REFER ALSO TO CITATION(S) 6804, 6967*

7005 (AGARD-CP—90, pp vp) **Effects of surface roughness on heat transfer to gas turbine blades.** Turner, A.B.; Tarada, F.H.A.; Bayley, F.J. Sep 1985. NTIS, PC A23/MF A01.

From Heat Transfer and Cooling in Gas Turbines; Bergen, Norway (6 May 1985).

A brief, preliminary sample of results of an investigation into the effect of surface roughness on heat transfer to gas turbine blades is presented. Only the kind of roughness due to the accretion of dirt or dust is considered and this has been simulated in cascade flow by attaching various grades of abrasive powders to the blade surface with a water soluble adhesive. A significant increase in heat is reported particularly with high free stream turbulent levels. Roughness on the pressure surface alone is shown to increase the overall heat transfer without any corresponding increase in profile loss.

7006 (AGARD-CP—90, pp vp) **Calculation of laminar-turbulent boundary layer transition on turbine blades.** Rodi, W.; Scheuerer, G. (Erlangen-Nuremberg Univ., West Germany). Sep 1985. NTIS, PC A23/MF A01.

From Heat Transfer and Cooling in Gas Turbines; Bergen, Norway (6 May 1985).

Calculations are presented for the flow development and heat transfer in transitional two-dimensional boundary layers of relevance to turbine blades. They were obtained with the Patankar-Spalding finite difference program, using a low Reynolds number version of the k-epsilon turbulence model for simulating the turbulent transport. For the higher free-stream turbulence levels prevailing in gas turbines (say above 1%), the model is capable of simulating the physical transition mechanism which is governed by the transport of the turbulent fluctuations from the free stream into the laminar boundary layer. The calculation examples comprise a variety of flat-plate boundary layers with various favorable and adverse pressure gradients as well as various levels of free-stream turbulence, and a simulation of the boundary layer development of an experimentally investigated turbine blade. The calculations are compared with measurements in each case (mainly the distribution of heat transfer coefficients). The agreement is generally good, but the model has a tendency to predict a somewhat faster transition than was observed in the experiments.

7007 (AGARD-CP—90, pp vp) **Computation of thermal radiation for gas turbine conditions.** Carvalho, M.G.; Durao, D.F.G.; Lockwood, F.C. (Imperial College of Science and Technology, London, England). Sep 1985. NTIS, PC A23/MF A01.

From Heat Transfer and Cooling in Gas Turbines; Bergen, Norway (6 May 1985).

The prediction of the fluid flow, combustion and heat release processes in a 'can' combustion chamber of a gas turbine is addressed. A three-dimensional numerical solution technique is used to solve the governing time-average partial differential equations and the physical modelling for the turbulence, combustion and thermal radiation. The thermal radiation modelling is emphasized in this paper. The implications of neglecting radiative heat transfer in gas turbine combustion chamber calculations are explored and discussed.

7008 (AGARD-CP—90, pp vp) **Effectiveness measurements for a cooling film disrupted by a single jet with wall plunging.** Button, B.L. Sep 1985. NTIS, PC A23/MF A01.

From Heat Transfer and Cooling in Gas Turbines; Bergen, Norway (6 May 1985).

Experimental measurements of the effectiveness downstream of a slot airflow with the jet airflow normal to the wall were performed in a wind tunnel. The separate and combined effects of the slot and jet airflows with and without wall plunging on the effectiveness and flow characteristics are presented over a range of slot and jet airflow conditions relevant to gas turbine combustors. The slot consisted of three rows of holes inclined at 10 degrees to the main airflow. The jet center line was positioned one, two and three diameters downstream from the slot exit. The jet diameter corresponded to five slot heights. Three wall plunge heights were used and corresponded to : 02, 0.4 and 12 jet diameters. The main airflow was constant at a Mach number of 0.05 and various combinations of the slot mass velocity ratio (0.5, 1.0 and 1.5) with the jet mass velocity ratio (0.5, 1.0 and 2.0) were tested. The effectiveness measurements covered an area eight jet diameters downstream of the slot exit by four jet diameters laterally. The results show that the major interactions between the three airflows occur downstream of the jet center line in a small region about three diameters long and two diameters wide. In general, such interactions reduce the effectiveness by up to forty percent when compared to the values with no jet injection. The combined and the separate effectiveness of the slot airflow and of the jet airflow are presented.

7009 (AGARD-CP—90, pp vp) **Isentropic light piston annular cascade facility at RAE Pyestock.** Brooks, A.J.; Colbourne, D.E.; Wedlake, E.T.; Jones, T.V.; Oldfield, M.L.G.; Schultz, D.L.; Loftus, P.J. (Oxford Univ., England; Maryland Univ., College Park). Sep 1985. NTIS, PC A23/MF A01.

From Heat Transfer and Cooling in Gas Turbines; Bergen, Norway (6 May 1985).

An accurate assessment of heat transfer rates to turbine vanes and blades is an important aspect of efficient cooling system design and component life prediction in gas turbines. Techniques have been developed at Oxford University which permit such measurements to be obtained in test rigs which provide short duration steady flow through a turbine cascade. The temperature ratio between the gas stream and the turbine correctly models that found in an engine environment. Reynolds number and Mach numaber can be varied over a wide range to match engine conditions. The design, construction and operation of a new facility at Royal Aircraft Establishment (RAE) Pyestock, incorporating these techniques, is described. Heat transfer and aerodynamic measurements have been made on airfoil surfaces and endwalls of a fully annular cascade of nozzle guide vanes. These results are discussed and compared with those obtained from the same profile in 2-D cascade tests, and with computed 3-D flow predictions.

7010 (AGARD-CP—90, pp vp) **Aerodynamic effect of coolant ejection in the rear part of transonic rotor blades.** Kost, F.H.; Holmes, A.T. (Rolls-Royce Ltd., Bristol, England). Sep 1985. NTIS, PC A23/MF A01.

From Heat Transfer and Cooling in Gas Turbines; Bergen, Norway (6 May 1985).

An investigation of transonic turbine blades designed by Rolls-Royce/Bristol concerning the aerodynamic penalties of coolant flow for two alternative cooling configurations is discussed. Rolls-Royce designed a blade with a thick trailing edge where the coolant is ejected through slots in the trailing edge and a second blade with a thin trailing edge where coolant is ejected through a row of holes on the pressure side and a row of holes on the suction side. Tests were performed in a plane cascade wind tunnel. The results indicate the sensitivity of the blade performance to cooling configuration and coolant flow rate. By combining measured data from blade surface and wake traverses it was possible to separate the various loss mechanisms. Therefore, the separate losses due to the momentum of the coolant, change of base pressure, and change of blade friction could be determined quantitatively as a function of coolant flow rate.

7011 (N—86-28375) **Feasibility study of optical boundary layer transition detection method. Final report, 22 February 1983-15 November 1985.** Azzazy, M.; Modarress, D.; Trolinger, J.D. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Jun 1986. 179p. (NASA-CR—178109; NAS—1.26:178109). NTIS, PC A09/MF A01.

A high sensitivity differential interferometer was developed to locate the region where the boundary layer flow undergoes transition from laminar to turbulent. Two laboratory experimental configurations were used to evaluate the performance of the interferometer: open shear layer, and low speed wind tunnel turbulent spot configuration. In each experiment, small temperature fluctuations were introduced as the signal source. Simultaneous cold wire measurements were compared with the interferometer data. The comparison shows that the interferometer is sensitive to very weak phase variations in the order of 0.001 the laser wavelength. An attempt to detect boundary layer transition over a flat plate at NASA-Langley Unitary Supersonic Wind Tunnel using the interferometer system was performed. The phase variations during boundary layer transition in the supersonic wind tunnel were beyond the minimum signal-to-noise level of the instrument.

7012 (N—86-29156) **Flow in out-of-plane double S-bends.** Schmidt, M.C.; Whitelaw, J.H.; Yianneskis, M. (Imperial Coll. of Science and Technology, London (UK)). Jun 1986. 67p. (NASA-CR—176981; NAS—1.26:176981). NTIS, PC A04/MF A01.

Developing flows in two out-of-plane double S-bend configurations have been measured by laser-Doppler anemometry. The first duct had a rectangular cross-section 40mmx40mm at the inlet and consisted of a uniform area 22.5 deg. - 22.5 deg. S-duct upstream with a 22.5 deg.- 22.5 deg. S- diffuser downstream. The second duct had a circular cross section and consisted of a 45 deg. - 45 deg. uniform area S-duct upstream with a 22.5 deg. -22.5 deg. S-diffuser downstream. In both configurations the ratio of the mean radius of curvature to the inlet hydraulic diameter was 7.0, the exit-to-inlet area ratio of the diffusers was 1.5 and the ducts were connected so that the centerline of the S-duct lay in a plane normal to that of the S-diffuser. Streamwise and cross-stream velocity components were measured in laminar flow for the rectangular duct and in turbulent flow for both configurations; measurements of the turbulence levels, cross-correlations and wall static pressures were also made in the turbulent flow cases. Secondary flows of the first kind are present in the first S-duct and they are complemented or counteracted by the secondary flows generated by the area expansion and by the curvature of the S-diffusers downstream. Cross-stream velocities with magnitudes up to 0.19 and 0.11 of the bulk velocity were measured in the laminar and turbulent flows respectively in the rectangular duct and six cross-flow vortices were evident at the exit of the duct in both flow cases. The turbulent flow in the circular duct was qualitatively similar to that in the rectangular configuration, but the cross-stream velocities measured at the exit plane were smaller in the circular geometry. The results are presented in sufficient detail and accuracy for the assessment of numerical calculation methods and are listed in tabular form for this purpose.

7013 (N—86-30095) **Optical diagnostics of gas-dynamic flows using advanced laser measurement techniques. Final report, 1 October 1983-31 December 1984.** Gross, K.P. (Polyatomics Research, Inc., Mountain View, CA (USA)). Jul 1985. 61p. (NASA-CR—176950; NAS—1.26:176950). NTIS, PC A04/MF A01.

Using laser-induced fluorescence to probe nitrogen flows seeded with small amounts of nitric oxide, simultaneous measurements of all three thermodynamic scalar quantities temperature, density, and pressure, were demonstrated in a supersonic turbulent boundary layer. Instrumental uncertainty is 1% for temperature and 2% for density and pressure, making the techniques suitable for measurements of turbulent fluctuations. This technology is currently being transferred to an experimental program designed to use these optical techniques in conjunction with traditional methods to make measurements in turbulent flowfields that were not possible before. A detailed descritpion of the research progress and pertinent results are presented.

7014 (N—86-30099) **Modeling of transient heat pipe operation. Semiannual status report, 19 August 1985-18 February 1986.** Colwell, G.T.; Hartley, J.G. (Georgia Inst. of Tech., Atlanta (USA)). Jun 1986. 32p. (NASA-CR—177143; NAS—1.26:177143). NTIS, PC A03/MF A01.

Mathematical models and associated solution procedures which can be used to design heat pipe cooled structures for use on hypersonic vehicles are being developed. The models should also have the capability to predict off-design performance for a variety of operating conditions. It is expected that the resulting models can be used to predict startup behavior of liquid metal heat pipes to be used in reentry vehicles, hypersonic aircraft, and space nuclear reactors. Work to date related to numerical solutions of governing differential equations for the outer shell and the combination capillary structure and working fluid is summarized. Finite element numerical equations using both implicit, explicit, and combination methods were examined.

7015 (N—86-30160, pp vp) **Two-phase flows within systems with ambient pressure.** Hendricks, R.C.; Braun, M.J.; Wheeler, R.L. III; Mullen, R.L. (Akron Univ., OH; Case Western Reserve Univ., Cleveland, OH). Dec 1985. NTIS, PC A21/MF A01. (NASA-CP—2409; E—2652; NAS—1.55:2409).

From Instability in Rotating Machinery; Carson City, NV, USA (10 Jun 1985).

In systems where the design inlet and outlet pressures are maintained above the thermodynamic critical pressure, it is often assumed that two phase flows within the system cannot occur. Designers rely on this simple rule of thumb to circumvent problems

associated with a highly compressible two phase flow occurring within the supercritical pressure system along with the uncertainties in rotor dynamics, load capacity, heat transfer, fluid mechanics, and thermophysic property variations. The simple rule of thumb is adequate in many low power designs but is inadequate for high performance turbomachines and linear systems, where two phase regions can exist even though outlet pressure is greater than critical pressure. Rotordynamic-fluid-mechanic restoring forces depend on momentum differences, and those for a two phase zone can differ significantly from those for a single-phase zone. Using the Reynolds equation the angular velocity, eccentricity, geometry, and ambient conditions are varied to determine the point of two phase flow incipience.

7016 **(N—86-30958) Simulation and modeling of homogeneous, compressed turbulence.** Wu, C.T.; Ferziger, J.H.; Chapman, D.R. (Stanford Univ., CA (USA)). May 1985. 206p. (NASA-CR—176939; NAS—1.26:176939; SU-TF—21). NTIS, PC A10/MF A01.

Low Reynolds number homogeneous turbulence undergoing low Mach number isotropic and one-dimensional compression was simulated by numerically solving the Navier-Stokes equations. The numerical simulations were performed on a CYBER 205 computer using a 64 x 64 x 64 mesh. A spectral method was used for spatial differencing and the second-order Runge-Kutta method for time advancement. A variety of statistical information was extracted from the computed flow fields. These include three-dimensional energy and dissipation spectra, two-point velocity correlations, one-dimensional energy spectra, turbulent kinetic energy and its dissipation rate, integral length scales, Taylor microscales, and Kolmogorov length scale. Results from the simulated flow fields were used to test one-point closure, two-equation models. A new one-point-closure, three-equation turbulence model which accounts for the effect of compression is proposed. The new model accurately calculates four types of flows (isotropic decay, isotropic compression, one-dimensional compression, and axisymmetric expansion flows) for a wide range of strain rates.

7017 **(OEFZS—334) Method for measuring two-phase mass flow using a turbine and a venturimeter only.** Sonneck, G.; Steiner, R.; Windberg, P.; Maroti, L. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H.). Sep 1985. 14p. (RS—265/85; ESA—86-97069; CONF-850646—11). NTIS HC A02/MF A01.

From 2. international specialists meeting on small break LOCA analysis in LWRs; Pisa, Italy (24 Jun 1985).

An air-water loop for steady-state investigations was built. Experiments using a spool piece including a full flow turbine and a venturimeter are described. It is shown that in the given configuration and within the investigated mass flows a turbine and a venturimeter only are sufficient to measure the total mass flow by determining simultaneously gas and liquid mass flows. However, the analysis can only justify qualitatively the measured values so that no extrapolation over a bigger range is possible. The instruments must be calibrated for each desired condition.

7018 **(REPT—4/70) Study of a low Reynolds flow around a cylinder: experimental set-up.** Beluche, F. (Institut de Mecanique des Fluides, 13 - Marseille (France)). Dec 1984. 30p. (In French). (IMFL—3115). NTIS, PC A03/MF A01.

A hydrodynamic tunnel, a flow visualization system, a holographic device, and a laser-Doppler velocimeter provided with a photon correlation system are described. The elements were tested and prove adequate for experiments at 2.5 to 8 cm/sec velocities.

7019 **Three-dimensional gas concentration and gradient measurements in a photoacoustically perturbed jet.** Yip, B.; Fourguette, D.C.; Long, M.B. (Yale University, P.O. Box 2157, Yale Station, New Haven, Connecticut 06520-2157). *Applied Optics;* **25**: No. 21, 3919-3923(1 Nov 1986).

The 3-D measurement of the gas concentration in a photoacoustically forced gas jet is described. A pulsed laser focused onto a laminar gas flow was used to trigger a localized disturbance which envolved with time. After a fixed time delay, the gas concentration in a 2-D cross section of the jet was measured by recording Rayleigh scattering from a second laser used to illuminate a thin sheet intersecting the flow. A series of these 2-D measurements made at the same time delay resulted in a full 3-D mapping of structures within the flow. Computer graphics enabled the subsequent reconstruction and visulization of the 3-D surfaces of constant concentration as well as the magnitude of the concentration gradient on such surfaces.

7020 **(BLL-M—6723-(5828.4)) Calculating the temperature and stresses when one side of a plate is heated with a constant flow of heat.** Guba, V.M.; Postolnik, Y.S. (British Library, Boston Spa. Document Supply Centre). 1986. Translation of Iz. (USSR), 119-122. 8p. British Library Lending Div., Boston Spa, England.

A mathematical procedure based on earlier work is given for determining the temperature and stress fields in plates, one of the surfaces of which is heated by a constant flow of heat and the other by convection from the ambient atmosphere. A model is used, and approximate analytical relationships are obtained for calculating the temperature and streses in plates. The procedure is applied to free plates and plates rigidly held.

7021 **Construction of and measurements with an extremely compact cross-flow heat exchanger.** Swift, G.; Migliori, A.; Wheatley, J. (Los Alamos National Lab., NM). *Heat Transfer Engineering;* **6**: No. 2, 39-47(1985).

An extremely compact cross-flow heat exchanger is described. The exchanger is constructed by furnace-brazing together a stack of hundreds of stainless-steel sheets. The resulting structure is leak-tight and very strong, but fluid channels as small as 51 μm (0.002 in) are not plugged by excess brazing material. Measurements of heat transfer between water and liquid propylene flowing through the heat exchanger are in excellent agreement with calculations based on exchanger geometry and fluid properties. 15 references, 5 figures, 3 tables.

7022 **Analysis of influence of steam superheating on packed-bed quench phenomena.** Ginsberg, T. (Brookhaven National Lab., Upton, NY). *AIChE (American Institute of Chemical Engineers) Symposium Series;* **81**: No. 245, 273-281(1985).

Experimental data suggest that steam produced within a particle bed, which is being quenched by flow from an overlying pool of water, has a strong potential for being superheated. This is a result of heat transfer from the unquenched particulate in the dry channels of the bed. A model is presented for the debris bed quench process, which considers the effects of steam superheat on both the bed heat flux and on the quench front propagation characteristics. Calculations presented demonstrate the effects of steam superheat. A preliminary comparison of the model, with experimental data from packed-bed quench experiments is also presented. 9 references, 5 figures.

## 4205 Materials Testing

*REFER ALSO TO CITATION(S) 6893*

7023 **(RISO-M—2586) Elastic-plastic fracture mechanics analysis of a CT-specimen. A two-dimensional approach.** Larsen, G.C. (Risoe National Lab., Roskilde (Denmark)). Jun 1986. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750160.

This report documents the results obtained from an elastic-plastic finite-element analysis of a compact tension specimen. The geometry of the model has been slightly modified compared to the physical specimen, but this is not considered to influence the results. The analysis comprises a plane strain as well as a plane stress approximation. The results presented include applied loads and displacements at certain locations. Moreover, the J-integral and the crack displacement have been presented. The plane strain and the plane stress approximation have been compared and the plane stress approximation is believed to deliver the best results. The results have been obtained using the finite-element code ADINA and the postprocessor code JINT.

7024 **(RISO-R—536) Calculations for piezoelectric ultrasonic transducers.** Jensen, H. (Risoe National Lab., Roskilde (Denmark)). May 1986. 97p. NTIS (US Sales Only), PC A05/MF A01. File Number DE87750158.

Analysis of piezoelectric ultrasonic transducers implies a solution of a boundary value problem, for a body which consists of different materials, including a piezoelectric part. The problem is dynamic at frequencies, where a typical wavelength is somewhat less than the size of the body. Radiation losses as well as internal losses may be important. Due to the complexity of the problem, a closed form solution is the exception rather than the rule. For this reason, it is necessary to use approximate methods for the analysis. Equivalent circuits, the Rayleigh-Ritz method, Mindlin plate theory and in particular the finite element method are considered. The finite element method is utilized for analysis of axisymmetric transducers. An explicit, fully piezoelectric, triangular ring element, with linear variations in displacement and electric potential is given. The influence of a fluid half-space is also given, in the form of a complex stiffness matrix. A special stacking procedure, for analysis of the backing has been developed. This procedure gives a saving, which is similar to that of the fast fourier transform algorithm, and is also wellsuited for analysis of finite and infinite waveguides. Results obtained by the finite element method are shown and compared with measurements and exact solutions. Good agreement is obtained. It is concluded that the finite element method can be a valueable tool in analysis and design of ultrasonic transducers. 64 refs.

## 4208 Electronic Circuits And Devices

*REFER ALSO TO CITATION(S) 7819*

7025 **Laser direct-write process for fabrication of VLSI gate-array interconnects.** McWilliams, B.M. (Lawrence Livermore National Lab., Special Studies Group, P.O. Box 5503, Livermore, CA 94550). pp 148 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Progress toward demonstrating an LP-based process for wiring state-of-the-art VLSI gate arrays with two-level interconnect structures is reviewed. Also discussed are long-range goals for refining a complete set of LP processes for fabricating fully customized integrated circuits.

7026 **Exploding metallic fuse physics experiments.** Goforth, J.H.; Hackett, K.E.; Lindemuth, I.R.; Lopez, E.A.; McCullough, W.F.; Dona, H.; Reinovsky, R.E. (Los Alamos National Lab.). pp 23 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The ultimate practicality of inductive pulse compression systems as drivers for energetic plasma implosions hinges on the development of a suitable opening switch capable of interrupting tons of megamp currents in time scales of a few hundred nanoseconds while withstanding L(dI/dt) voltages of a megavolt or more. 1. Exploding metallic foils (fuses) are a candidate for switching elements in the inductive store pulsed power systems used in the Los Alamos and Air Force Weapons Laboratory foil implosion X-ray source generation programs. To verify or modify new theoretical and computational predictions about the electrical and hydrodynamic behavior of exploding metallic foils used as fuses. The authors have initiated a new series of small scale capacitor bank driven fuse experiments. The experiments represent an extension of previous experiments, but in the new series a foil geometry more amenable to theoretical and computational analysis is used. The metallic foil (aluminum or copper) is laminated between two thin layers of insulating material (mylar or kaptan). Adjacent to one layer of insulation is a much heavier backing insulator (polyethylene) whereas air is adjacent to the other layer. Because of the differing masses on the two sides of the foil, the foil expansion and hydrodynamic motion is essentially one-sided and the layer of insulation on the expanding side becomes a readily-characterizable "flyer" which provides a controlled amount of hydrodynamic tamping. In addition to the usual voltage, current, and dI/dt electrical measurements, time-resolved spectrometer measurements are used to determine the temperature of the expanding metallic foil. Post-shot examination of the flyer and the insulation impacted by the flyer gives insight into the experimental behavior.

7027 **Review of explosive-driven opening switch techniques.** Goforth, J.H. (Los Alamos National Lab., Los Alamos, NM 87545). pp 60 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Explosive devices that use very small quantities of explosive can interrupt very large currents flowing in circuits that can conduct for very long times. Such devices, however, typically open slowly. Fast-opening switches can also be made using explosives techniques. In order to achieve fast opening times, however, larger quantities of explosive or elaborate detonation systems may be required. Typically, a switch that can conduct a peak current of $\approx$1 MA on a millisecond time scale can be opened using a fraction of a gram of explosive in $\approx$40 $\mu$s given adequate voltage relief. A different switch that can conduct $\approx$10 MA with a risetime of 500 $\mu$s should be capable of opening in $\approx$2 $\mu$s with an appropriately matched load, but requires $\approx$200 kg of explosive. Yet another device that conducts pulses rising to 5-10 MA in $\approx$50 $\mu$s, then opens on a submicrosecond time scale, uses $\approx$40 kg of explosive. An overview of the variety of explosive devices available is presented, and an update on various areas of current research and development. Included are specific device parameters and scaleability.

7028 **Planar & radial UV-sustained glow discharge opening switches.** Moeny, W.M.; von Dadelszen, M. (Tetra Corp., Albuquerque, NM 87109). pp 22 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

This paper reports small scale glow discharge kinetics experiments and theoretical analyses conducted with the ELF codes in preparation for design and development of a full-scale radial opening switch in 1986. In the small scale experiments, the majority of gas mixes were N/sub 2/ based to take advantage of the 108 nm UV emission Trimethylamine (TMA) that was used as the photoionization seedant because of its relatively large photoionization cross section at 108 nm. The attachers used were CF/sub 4/ and NO and Helium was used as a buffer gas, frequently as the major constituent.

## 4209 Waste Processing Plants And Equipment

*REFER ALSO TO CITATION(S) 6456*

## 4210 Combustion Systems

*REFER ALSO TO CITATION(S) 6471, 6490, 7005, 7006, 7007, 7008, 7009, 7010*

7029 **(AD-A—171724/8/XAB) Investigation into the effects of fuel additives and fuel composition on soot-particle size in a T63 gas-turbine combustor using light transmittance and scattering techniques. Master's thesis.** Hua, J.C. (Naval Postgraduate School, Monterey, CA (USA)). Jun 1986. 75p. NTIS, PC A04/MF A01.

An experimental investigation was conducted to examine the effects of fuel-air ratios, fuel composition, and smoke-suppressant fuel additives on the sooting characteristics of a T-63 combustor. Multiple-wavelength light transmission and two-angle light-scattering measurements were used to measure the mean soot diameter. Ferrocene, 12% Cerium Hex-Cem, and USLAD 2055 were found effective in reducing exhaust gas opacity. Initial results were conflicting on the cause for the reduced opacity.

7030 **Impact of reduced firing rate on furnace and boiler efficiency.** Andrews, J.W. (Brookhaven National Lab., Upton, NY). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* **92**: No. 1A, 246-262(1986). (CONF-860106—).

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

A theoretical treatment of firing rate and efficiency of furnaces and boilers was developed and validated against experimental data. The effect on efficiency, both steady-state and under cycling conditions, was then studied. Results were obtained that shed light on the relationship between firing rate and cycle efficiency. Some impediments to the achievement of all of the expected improvement in steady-state efficiency were also elucidated.

### 4240 Pollution Control Equipment

7031 **Apparatus for measuring the decontamination factor of a multiple filter air-cleaning system.** Oritz, J.P. (to Dept. of Energy, Washington, DC). US Patent 4,619,136. 28 Oct 1986. Filed date 3 Jul 1985. v.p.

An apparatus is described for measuring the overall decontamination factor of first and second filters, the first and second filters being located in a plenum having an upstream chamber, an intermediate chamber, and a downstream chamber. The first filter is located between the upstream and intermediate chambers and the second filter is located between the intermediate and downstream chambers. The apparatus comprises a. an aerosol generator for producing a challenge aerosol composed of individual particles, the aerosol generator being in fluid communication with the upstream chamber; b. an upstream collector for collecting the challenge aerosol before the challenge aerosol enters the first filter, the upstream collector being disposed in the upstream chamber; c. an intermediate collector for collecting the challenge aerosol that passes through the first filter, the intermediate collector being disposed in the intermediate chamber; and d. a downstream collector for collecting the challenge aerosol that passes through the second filter, the downstream collector being disposed in the downstream chamber.

### 4250 Power Cycles

*REFER ALSO TO CITATION(S) 6681, 6801*

## 43 PARTICLE ACCELERATORS

### 4301 Design, Development, And Operation

*REFER ALSO TO CITATION(S) 7164, 7682*

7032 (DOE/ER/40238—1, pp 3383-3385) **Conceptual design of the Argonne 6-GeV synchrotron light source.** Cho, Y.; Crosbie, E.; Khoe, T.; Knott, M.; Kramer, S.; Kustom, R.; Lari, R.; Martin, R.; Mavrogenes, G.; Moenich, J.; Norem, J. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract W-31-109-ENG-38.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The Argonne National Laboratory Synchrotron Light Source Storage Ring is designed to have a natural emittance of 6.5 x $10^{-9}$ m for circulating 6-GeV positrons. Thirty of the 32 long straight sections, each 6.5-m long, will be available for synchrotron light insertion devices. A circulating positron current of 300 mA can be injected in about 8 min. from a booster synchrotron operating with a repetition time of 1.2 sec. The booster synchrotron will contain two different RF systems. The lower frequency system (38.97 MHz) will accept positrons from a 360-MeV linac and will accelerate them to 2.25 GeV. The higher frequency system (350.76 MHz) will accelerate the positrons to 6 GeV. The positrons will be produced from a 300-MeV electron beam on a tungsten target. A conceptual layout is shown.

7033 (DOE/ER/40238—1, pp 3397-3399) **Boeing 120 MeV RF linac for FEL research.** Adamski, J.L.; Gallagher, W.J.; Kennedy, R.C.; Robinson, B.; Shoffstall, D.R.; Tyson, E.L.; Vetter, A.M.; Yeremian, A.D. (Boeing Aerospace Co., Seattle, WA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A new electron linac for high power, visible wavelength, free electron laser research is under construction at the Boeing Radiation Laboratory in Seattle. The linac is a five section, traveling wave, L band structure with a specialized comb pulse format of widely separated high charge micropulses. The paper describes the accelerator design and prototyping of key components of the linac. These include a double subharmonic injector and a long pulse phase and amplitude stabilized RF source which have been tested on Boeing's 20 MeV S band linac.

7034 (DOE/ER/40238—1, pp 3424-3426) **Physics design for the ATA tapered wiggler.** Fawley, W.M. (Lawrence Livermore National Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract W-7405-ENG-48.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors are presently designing and constructing a high-gain, tapered wiggler 10.6 $\mu$ FEL amplifier to operate with the 50 MeV ATA e-beam. The initial experiments will be done with a constant period ($\gamma$/sub w/ = 8 cm), 5 m-long linear wiggler. For an input laser power of 800 MW and electron beam brightness of $2.10^5$ A/(rad-cm)$^2$, they hope to achieve a trapped particle fraction $\sim$0.5 and an energy extraction efficiency of $\sim$2% with a $\sim$10% taper in the wiggler magnetic field. This taper corresponds to decelerating the trapped particle approximately two full ponderomotive well (i.e. Bucket) heights. In this talk, they will discuss the physics motivations behind their tapered wiggler design and initial experimental diagnostics.

7035 (DOE/ER/40238—1, pp 3471-3475) **Wake field work at DESY.** Weiland, T. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

At DESY, the authors are investigating the applicability of the Wake Field Transformer concept for high gradient acceleration of particles. In this paper they will focus on the experiment which is under construction. The authors have built a 8 MeV high current linac for generation of a hollow driving beam of 1 $\mu$Coulomb charge. The hollow beam gun came into operation in March 1985 and is laser driven with a tungsten (or tantalum) cathode. This new type of gun does not need extremely high vacuum and is very reliable. The linac will come into operation in May. By the end of 1985, they hope to have first results from the Wake Field Transformer operation. All parts including the gun, linac cavities, solenoid coils and the transformer have already been manufactured.

7036 (DOE/ER/40238—1, pp 3476-3480) **Two-beam accelerator: structure studies and 35 GHz experiments.** Hopkins, D.B.; Kuenning, R.W. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The Two-Beam Accelerator (TBA) shows great promise for achieving high accelerating gradients, perhaps >250 MV/m, for such machines as electron linear colliders. This paper presents the results of studies of candidate structures for a TBA. Also, the hardware and program for 35 GHz high-gradient testing is described.

7037 (DOE/ER/40238—1, pp 3481-3485) **Collective acceleration and the propagation of intense beams into vacuum.** Destler, W.W.; O'Shea, P.G.; Segalov, Z. (Univ. of Maryland, College Park). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In this paper, the authors detail new experimental work that has relevance to both the naturally occurring collective acceleration experiments and to the Beam Front Accelerators. The relationship between the collective acceleration of ions and the resultant propagation of the injected electron beam into vacuum has been explored. These results have shed valuable new light on the acceleration process in localized ion source experiments, and may allow a more careful design of Beam Front Accelerators designed to further enhance the accelerated ion energy.

7038 (DOE/ER/40238—1, pp 3486-3488) **Periodic plasma waveguide accelerator.** Cole, F.T. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In a plasma accelerator, the plasma can have several different functions. It may act as a medium for the propagation of accelerating electric-field waves. In addition, these waves may also act as a source of the energy needed to accelerate particles. Accelerators using various waves in plasmas have been built and studied in many laboratories. The device proposed here is an attempt to separate the two functions of providing a medium and providing an energy source. A relatively low-energy electron beam is used as a non-neutral plasma only to make a slow-wave medium for the propagation of an externally generated wave. The wave is a TM electro-magnetic wave and the device may be thought of as a conventional electron linear accelerator with the evacuated volume and metallic envelope replaced by the electron beam. A separate second beam which may be electrons or heavier particles, is accelerated. The application in mind here is a single-pass collider.

7039 (DOE/ER/40238—1, pp 3489-3491) **Collective accelerator for electron colliders.** Briggs, R.J. (Lawrence Livermore National Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A recent concept for collective acceleration and focusing of a high energy electron bunch is discussed, in the context of its possible applicability to large linear colliders in the TeV range. The scheme can be considered to be a member of the general class of two-beam accelerators, where a high current, low voltage beam produces the acceleration fields for trailing high energy bunch.

7040 (DOE/ER/40238—1, pp 3492-3493) **Measurement facility for new acceleration techniques.** Simpson, J.; Norem, J.; Schoessow, P.; Cole, F.; Ruggiero, A.G. (Argonne National Lab, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Interest in developing new, high gradient acceleration techniques is growing rapidly. Experimental investigation of new concepts, however, lags noticeably behind the ideas. To a large extent this situation arises simply because the very specialized beams and diagnostics required to make the necessary measurements are not available. A facility is being constructed at ANL which will permit the direct measurement of wake fields for a variety of experimental conditions. A single, short bunch of 22 MeV electrons from an existing linac is manipulated to form two separate pulses which can be set to a specified time and space separations. Normally, the leading pulse will be an intense, full energy pulse of a few times $10^{10}$ electrons less than 10 psec in length. The trailing witness pulse will be at roughly 3/4 the energy of the leading pulse, will contain fewer electrons, and will have the same pulse length as the leading driver pulse. Energy gain/loss and deflections of each pulse will be measured after the bunch doublet has passed through the wake structure under test. Design specifications and project status are presented.

7041 (DOE/ER/40238—1, pp 3500-3502) **Considerations on collective ion acceleration as an intense ion injector.** Faehl, R.J.; Peter, W.K. (Los Alamos National Lab., NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A virtual cathode collective acceleration configuration is examined for use as a pulsed, intense ion injector. Numerical calculations of the collective acceleration have shown peak ion energies of several times that of the electron beam energy. This is consistent with a variety of experiments. The late time behavior is to accelerate ions to lower energies but at a higher current. This is characteristic of a reflex ion triode, which produces an ion beam largely charge but not current neutralized. Dynamic neutralization must be achieved if accelerator applications, requiring transport and focusing, are to be realized. Representative applications have been simulated and are discussed.

7042 (DOE/ER/40238—1, pp 3503-3505) **Studies of the plasma droplet accelerator scheme.** Mori, W.B.; Joshi, C.; Dawson, J.M.; Lee, K.; Forslund, D.W.; Kindel, J.M. (Univ. of California, Los Angeles). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In the plasma droplet accelerator scheme, proposed by R. Palmer, a sequence of liquid micro-spheres generated by a jet printer are ionized by an incoming intense laser. The hope is that the micro-spheres now acting as conducting balls will allow efficient coupling of the incoming laser radiation into an accelerating mode. Motivated by this the authors have carried out 2D, particle simulations in order to answer some of the plasma physics questions hitherto unaddressed. In particular they find that at least for laser intensities exceeding $v_o/c=0.03$ (/sup $\sim$/$10^{18}$w/cm$^2$ for a $CO_2$ laser), the incident laser light is rather efficiently absorbed in a hot electron distribution. Up to 70% of the incident energy can be absorbed by these electrons which rapidly expand and fill the vacuum space between the microspheres with a low density plasma. These results indicate that it is advisable to stay clear of plasma formation and thus put on an upper limit on the maximum surface fields that can be tolerated in the droplet-accelerator scheme.

7043 (DOE/ER/40238—1, pp 3506-3508) **Collective ion acceleration by means of virtual cathodes.** Peter, W.; Faehl, R.J.; Snell, C.; Jones, M.E. (Los Alamos National Lab., NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A theoretical and computational effort is underway at Los Alamos in order to clarify the basic issues of collective ion acceleration by means of virtual cathodes. To support the theoretical effort simulations were done with the fully electromagnetic and relativistic particle-in-cell code ISIS (in a one-dimensional mode) and the electrostatic one-dimensional code BIGONE. In the simulations, an electron beam of density $6 \times 10^{11}$ cm$^{-3}$ is injected into a one-dimensional box of length L. To supply the necessary ions for collective acceleration, a plasma source containing both ions and electrons was initialized near the emitting boundary. This is similar to the experimental configuration of Destler's group at Maryland. Of prime interest in this study was to understand the dynamics of virtual cathode formation and the dynamics of the acceleration process for the ions. In particular, the question of whether the ions are accelerated by a moving potential well or hydrodynamic pressure due to ambipolar expansion is of primary interest. For this reason, the simulations were done in one-dimension in order to isolate the basic physical processes underlying collective ion acceleration from simple geometric effects. These simulations were then compared to 2-1/2 dimensional ISIS runs.

7044 (DOE/ER/40238—1, pp 3509-3511) **Overview and status of the transverse-field focusing (TFF) accelerator.** Anderson, O.A.; Chan, C.F.; Cooper, W.S.; Kwan, J.W.; Matuk, C.A.; Owren, H.M.; Paterson, J.A.; Purgalis, P.; Soroka, L. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The Transverse Field Focusing (TFF) system described here is a prototype for a negative-ion based neutral beam line with possible applications in the US magnetic fusion energy program. The prototype system consists of four main modules: (1) $H^-$ source, (2) 80 keV pre-accelerator, (3) TFF matching/pumping (M/P) section, and (4) 180 keV TFF accelerator. The first three modules have been installed on the beam line, with the fourth to follow soon. The crucial module, invoking the most difficult (and interesting) physics and engineering issues, is the M/P section. It performs: (a) gas removal from the beam by differential pumping, (b) electron removal, (c) beam thickness reduction to match the TFF accelerator parameters, and (d) beam-edge confinement. The four beamline modules are discussed in this survey, with emphasis on design features of the M/P section.

7045 (DOE/ER/40238—1, pp 3515-3517) **Preliminary design study of the NSWC protron induction linac.** Namkung, W.; Uhm, H.S. (Naval Surface Weapons Center, Silver, Spring, MD). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 5 MeV, 100 A, 3 μsec proton beam is required for the required for the injection into a compact accelerator which uses quadrupole lenses in a betatron-like device at NSWC. As an injector, an induction linac is proposed to utilize technologies developed in magnetic and heavy ion fusion research: a 50 keV, 100 A, 3 μsec proton beam extracted from an ion source used for the PDX-type neutral beam injector, is accelerated by induction modules. The beam size is reduced by solendoidal lenses in three steps as beam energy is increased. The matching section is followed before injection to the quadrupole channel. They present preliminary design details of the proposed intense, long-pulse proton linac.

7046 (DOE/ER/40238—1, pp 3518-3520) **Quadrupole betatron accelerator for high current ion beams.** Uhm, H.S.; Nguyen, K.T.; Namkung, W. (Naval Surface Weapons Center, Silver Spring, MD). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Properties of a strong non-neutral ion ring in a quadrupole betatron field are investigated. Superimposed on the axial betatron field, it is shown that the quadrupole field is necessary for the stability of the orbits where the self-fields of the ion ring are not negligible. A closed algebraic expression for the ion limiting current is obtained in terms of the quadrupole field intensity, the channel radius, the transverse temperature of ion beam, and the strength of betatron field. According to the theoretical calculation, high energy ion beam with its current order of one kiloampere can easily be attainable.

7047 (DOE/ER/40238—1, pp 3530-3532) **IFA-2 collective ion accelerator experiments.** Olson, C.L.; Frost, C.A.; Patterson, E.L.; Anthes, J.P.; Poukey, J.W. (Sandia National Labs., Albuquerque, NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Ion acceleration has now been demonstrated with the IFA-2 collective ion accelerator system. The IFA-2 system is described, photoionization experiments are summarized, and ion results are presented. Using a 1 MeV electron beam and a 30 cm acceleration length, IFA-2 has produced 5 MeV $H^+$, 10 MeV $D^+$, and 20 MeV $He^{++}$. This means that accelerating fields of 33 MV/m over 30 cm have been achieved with a controlled collective accelerator for the first time.

7048 (DOE/ER/40238—1, pp 3533-3535) **Coaxial pulse line accelerating structure.** Swenson, D.A. (Texas Accelerator Center, Woodlands). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A coaxial pulse line accelerating structure, conceived as a candidate for the linear collider application, where the goal is the acceleration of single micropulses of relativistic particles to very high energies at very high acceleration rates with minimal investment in stored energy, will be described. The structure consists of a coaxial transmission line surrounding a sequence of pillbox accelerating cells. Pulses of electromagnetic energy propagate along the transmission line, at the speed of light, feeding the accelerating cells where the energy converges to the axis producing very high gradient electric fields suitable for acceleration of short bursts of relativistic charged particles. The energy efficiency of the structure could be very high and the fill-time of the structure is essentially zero. One or more schemes for generating the intense electromagnetic pulses required by the system will be described. An example design of a 1-TeV Linear Lepton Collider (LLC) will be presented.

7049 (DOE/ER/40238—1, pp 3536-3538) **Experimental study of the electron beam produced by a plasma focus accelerator.** Schneider, R.F.; Rhee, M.J.; Smith, J.R. (Univ. of Maryland, College Park). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The electron beam produced by a compact pulsed plasma focus accelerator is investigated. In the prototype device, 5-20 ns electron beam pulses of several kA and particle energies of up to a few hundred keV have been produced. The rms emittance is found to be 1288 mm-mrad.

7050 (DOE/ER/40238—1, pp 3539-3541) **Experiments on the plasma beat-wave accelerator.** Ebrahim, N.A.; Lavigne, P.; Aithal, S. (Yale Univ., New Haven, CT). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors report an experimental study of the beat-wave excitation of plasma waves using a short pulse, high intensity $CO_2$ laser with two colinearly propagating beams to excite the fast wave (v/sub p/ $\sim$ c) in a long-scale-length underdense plasma. Maximum plasma wave amplitudes $n_1/n_0 \sim 0.19$ with effective longitudinal electric field gradients of $\sim$ 6 GV/m over a distance of 0.5 mm were achieved in these experiments.

7051 (DOE/ER/40238—1, pp 3542-3544) **Pump depletion and laser staging for beat-wave accelerator.** Tajima, T.; Horton, W.; Witte, K.; Singer, S. (Univ. of Texas, Austin). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The beat-wave accelerator (BWA) scheme is promising for a large acceleration gradient for high energies. Some of the concerns with this accelerator concept are (i) the longitudinal dephasing between the speed of high energy particles and that of plasmons and (ii) the laser pump depletion. The latter problem is analyzed in detail here. To cope with these problems and also to ease some of the requirements on laser and plasma parameters, the authors propose an accelerator architecture for BWA with the following features: (i) distributed laser staging optically connected by the master oscillator; (ii) optical delay lines synchronizing the timing and phase of each laser stage; (iii) appropriate mirror systems; and (iv) optical guides (plasma fiber) to trap laser beams by acoustic transducers or other mechanism. If necessary, additional collector devices may be

added to collect any unused portion of laser power and to convert it for reuse.

7052 (DOE/ER/40238—1, pp 3548-3550) **Modified two beam accelerator driven by a D.C. pelletron free electron laser.** Larson, D. (Univ. of Wisconsin, Madison). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Assembling the next generation of linear particle accelerators requires progress in three areas. (1) Sources must be developed to provide the coherent electromagnetic radiation used to power the device. (2) Physical structures must be designed which efficiently transfer the power to the high energy beam. (3) Cooling techniques must be developed in order to enhance beam transport and to provide sufficient luminosity. This paper will describe a method of obtaining a highly efficient coherent radiation source by using a continuous wave Free Electron Laser (FEL). Several possibilities exist for an accelerating structure which could use this radiation as a power source. These include scaling down the size of traditional RF cavities, inverse free electron lasers, and surface grating schemes. Inverse free electron lasers have the possibility of intrinsic cooling of the high energy beam.

7053 (DOE/ER/40238—1, pp 3551-3553) **Experimental study of the plasma beat wave accelerator.** Clayton, C.E.; Joshi, C.; Darrow, C.; Umstadter, D.; Chen, F.F. (Univ. of California, Los Angeles). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The physics of the beat-excited, relativisic electron plasma wave, a candidate for a laser particle accelerator, is studied in experiments at UCLA. Preliminary experiments have shown waves excited up to 1-3% of the cold wavebreaking amplitude, corresponding to longitudinal electric fields of 0.3-1.0 GeV/m. Issues addressed here include possible experimental limitations on the length, growth time, and amplitude of this plasma wave. Plans for future experiments on the acceleration of test charges will also be presented.

7054 (DOE/ER/40238—1, pp 3574-3577) **Superconducting heavy ion injector linac.** Shepard, K.W. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract W-31-109-ENG-38.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A conceptual design for a very low velocity superconducting heavy-ion linac is reviewed. This type of linac may have significant cost and performance advantages over room-temperature linacs, at least for applications requiring modest beam currents. Some general features of the design of very-low velocity superconducting accelerating structures are discussed and a design for a 48.5 MHz, v/c = .009 structure, together with the status of a niobium prototype, is discussed in detail. Preliminary results of a beam dynamics study indicate that the low velocity linac may be able to produce heavy-ion beams with time-energy spreads of a few KeV-nsec.

7055 (DOE/ER/40238—1, pp 3828-3833) **Very high energy colliders.** Richter, B. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Eventually, the author will want to build accelerators of much higher energy than those now talked about, and in this paper the author will do some large extrapolation to see what kind of machines those might be. It is not enough to consider energy, for it is also necessary that the intensity (luminosity) be sufficient to study the physical processes of interest. In looking at intensity issues he bases his analysis on the physics that he knows and some very general scaling laws. In looking at both electron and proton machines, the electron machines will turn out to be more promising and he will review the basic design principles of very high energy linear colliders.

7056 (DOE/ER/40238—1, pp 3834-3837) **Accelerators - instruments and symbols for power.** Vogt, E. (TRIUMF, Vancouver, British Columbia). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Accelerator physicists think big. They are zealots and they are impatient. This is the biggest gathering of the cult of accelerator physicists that has ever taken place. The world should be watching them. They examine the cult of accelerator physics and describe the laws which govern its development. To compare and contrast it with other similar cults in the past. To search for its driving force.

7057 **Electromagnetic 'particle-in-cell' plasma simulation.** Langdon, A.B. (Lawrence Livermore National Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 223-225(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

'PIC' simulation tracks particles through electromagnetic fields calculated self-consistently from the charge and current densities of the particles themselves, external sources, and boundaries. Already used extensively in plasma physics, such simulations have become useful in the design of accelerators and their rf sources.

7058 **Proceedings of the first Aspen Winter physics conference.** Block, M.M. New York, NY; The New York Academy of Sciences (1986). 532p. (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

These proceedings contain 43 papers divided into: 1. Collider physics at ultrahigh energies; 2. Electroweak interactions.

7059 **Database requirements for the Advanced Test Accelerator project.** Chambers, F.W. (Lawrence Livermore National Lab., Univ. of California, P.O. Box 808, Livermore, CA 94550). pp 407-419 of Proceedings of the eighteenth Hawaii international conference on system sciences. Volume 2. Shriver, B.D. Honolulu, HI; Hawaii International Conference on System Sciences (1985). (CONF-850131—). Contract W-7405-ENG-48.

From International conference on systems science; Honolulu, HI, USA (1 Jan 1985).

The database requirements for the Advanced Test Accelerator (ATA) project are outlined. ATA is a state-of-the-art electron accelerator capable of producing energetic (50 million electron volt), high current (10,000 ampere), short pulse (70 billionths of a second) beams of electrons for a wide variety of applications. Databasing is required for two applications. First, the description of the configuration of facility itself requires an extended database. Second, experimental data gathered from the facility must be organized and managed to insure full utilization. The two applications are intimately related since the acquisition and analysis of experimental data requires knowledge of the system configuration. This report reviews the needs of the ATA program and current implementation, intentions, and desires. These database applications have several unique aspects which are highlighted. The features desired in an ultimate database system are outlined.

## 4302 Beam Dynamics, Field Calculations, And Ion Optics

*REFER ALSO TO CITATION(S) 7163, 7230, 7231, 7232, 7233, 7234, 7236*

7060 **(BNL—38737) Chromatic perturbation and resonance strengths in SSC.** Parsa, Z. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 4p. (CONF-8606215—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002143.

From Summer study on the physics of the superconducting super collider; Snowmass, CO, USA (23 Jun 1986).

We have investigated the nonlinear effects of the SSC-CDR clustered lattice. In this note, we will give a brief theoretical discussion and an overview of some of our results using program HARMON. Tune diagrams for the structure resonances of the SSC are also included.

7061 **(DOE/ER/40136—T4) Electron acceleration by laser fields in a gas. Technical progress report.** Fontana, J.R. (California Univ., Santa Barbara (USA). Dept. of Electrical and Computer Engineering). 1 Oct 1986. Contract AS03-84ER40136. 40p. American Institute of Physics, 335 E. 45th St., New York, NY 10017. File Number TI87000192.

Improvements and refinements are reported for a simulation technique to trace an electron trajectory under simultaneous collision scatter by a gas and acceleration and focusing produced by laser fields. The method is applied to a cylindrical geometry. Examples are discussed and energy loss processes, besides elastic scattering, are studied. The problems and advantages of recirculating the laser pulse through the resonator and gain medium are discussed in the context of $CO_2$ laser kinetics. Considerations for carrying out actual measurements with a demonstrating device to study inverse Cherenkov acceleration and focusing are discussed together with the implications of a low energy acceleration injector. Laser beam configurations for cumulative interaction with electrons in a gas and simulation studies of gas collision effects in inverse Cherenkov accelerators are covered. (LEW)

7062 (DOE/ER/40238—1, pp 3494-3496) **Wave excitation in waveguides below cut-off.** Anselmo, A.; Nation, J.A. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 400 kV, 2kA, electron beam has been used to grow space charge waves in a 5.0 cm diameter drift tube. The waves are excited by propagating the pencil beam through a series of annular metallic rings with alternate rings grounded and the others capacitively coupled to the beam. Measurement have been made and will be presented of the wave characteristics downstream of the exciting structure. The wave excitation may result from a parametric excitation of eigenmodes of the beam in the guide.

7063 (DOE/ER/40238—1, pp 3497-3499) **Space-charge wavegrowth and propagation on a relativistic electron beam.** Greenwald, S.; Kerslick, G.; Nation, J.A. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A study into the growth and propagation of space charge waves on relativistic electron beams is currently in progress. The waves are grown by transporting an annular beam (180-200 kV, 0.8-1 kA, 300-400 ns) through a disc loaded cavity system. Measurements of the R.F. signal inside the slow wave structure and at both ends of this region show the presence of backward as well as forward space charge waves. In addition measurements of the average drift velocity of the beam electrons show high energy losses to the cavity system. Interactions between the beam, the cavity system, and at the discontinuity between the cavities and the uniform drift tube produce both fast and slow waves. Results showing this aspect of the wavegrowth processes and their effect on beam propagation are reported. The relevance of the results to collective acceleration are discussed.

7064 (DOE/ER/40238—1, pp 3512-3514) **Numerical simulation of secondary electron orbits near an electron beam propagating in a low pressure gas.** Teague, M.R.; Yu, S.S. (Lawrence Livermore National Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract W-7405-ENG-48.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A numerical simulation has been constructed to obtain a detailed, quantitative estimate of the electromagnetic fields generated in a recently-proposed collective accelerator scheme for electrons. The code treats the secondary electrons by particle simulation and the beam dynamics by a time-dependent envelope model. The simulation gives a fully relativistic description of secondary electrons moving in self-consistent electromagnetic fields. The calculations are made using coordinates t, s, y, z for the electrons and t, ct-z, r or the axisymmetric electromagnetic fields and currents. Code results showing the axial electric field dependence on the configuration of the ultrashort U.V. laser pulse will be given.

7065 (DOE/ER/40238—1, pp 3521-3523) **Plasma-focused cyclic accelerators.** Mondelli, A.A.; Chernin, D.P. (Science Applications International Corp., McLean, VA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The use of ambient plasma to neutralize the transverse forces of an intense particle beam has been known for many years. Most recently, the so-called ion-focused regime (IFR) for beam propagation has been used as a means of focusing intense electron beams in linear accelerators and suggested for injecting an electron beam across magnetic field lines into a high-current cyclic accelerator. One technique for generating the required background plasma for IFR propagation is to use a laser to ionize ambient gas in the accelerator chamber. This paper discusses an alternative means of plasma production for IFR, viz. by using RF breakdown. For this approach the accelerator chamber acts as a waveguide. This technique is not limited to toroidal accelerators. It may be applied to any accelerator or recirculator geometry as well as for beam steering and for injection or extraction of beams in closed accelerator configurations.

7066 (DOE/ER/40238—1, pp 3524-3526) **Collinear wake field acceleration.** Bane, K.L.F.; Chen, P.; Wilson, P.B. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In the Voss-Weiland scheme of wake field acceleration a high current, ring-shaped driving bunch is used to accelerate a low current beam following along on axis. In such a structure, the transformer ratio, i.e. the ratio of the maximum voltage that can be gained by the on-axis beam and the voltage lost by the driving beam, can be large. In contrast, it has been observed that for an arrangement in which driving and driven bunches follow the same path, and where the current distribution of both bunches is gaussian, the transformer ratio is not normally greater than two. This paper explores some of the possibilities and limitations of a collinear acceleration scheme. In addition to its application to wake field acceleration in structures, this study is also of interest for the understanding of the plasma wake field accelerator.

7067 (DOE/ER/40238—1, pp 3527-3529) **Phase velocity of nonlinear plasma waves in the laser beat-wave accelerator.** Spence, W.L. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The suggested plasma-laser accelerator is an attempt to achieve a very high energy gradient by resonantly exciting a longi-

tudinal wave traveling at close to the speed of light in cold plasma by means of the beat-wave generated by the transverse fields in two laser beams. Previous calculations to all orders in v/sub z/ have been done essentially from the laboratory frame point of view and have treated the plasma wave as having sharply defined phase velocity equal to the speed of light. However a high energy particle beam undergoing acceleration sees the plasma wave from a nearly light-like frame of reference and hence is very sensitive to small deviations in its phase velocity. Here the authors introduce a calculational scheme that includes all orders in v/sub z/ and in the plasma density, and additionally takes into account the influence of plasma nonlinearities on the wave's phase velocity. The main assumption is that the laser frequencies are very large compared to the plasma frequency - under which they are able to in essence formally sum up all orders of forward Raman scattering. They find that the nonlinear plasma wave does not have simply a single phase velocity - it is really a superposition of many - but that the beat-wave which drives it is usefully described by a non-local effective phase velocity function.

7068 (DOE/ER/40238—1, pp 3545-3547) **Study of the plasma fiber accelerator.** Zaidman, E.; Tajiman, T.; Neuffer, D.; Mima, K.; Ohsuga, T.; Barnes, D.C. (Univ. of Texas, Austin). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors study the plasma fiber accelerator concept by simulation and theory. An outgrowth of the laser beat-wave accelerator concept, the plasma fiber accelerator, sets the phase velocity of the beat plasma wave at the speed of light (or any value desired) by allowing each laser light to have a specific transverse wavenumber (or structure). Two-dimensional slab duct structures with laser beams of both transverse electric and transverse magnetic polarizations are explored. Accelerated beam dynamics in fiber beat-wave is discussed.

7069 (LA-UR—86-3640) **Laser focusing of high-energy charged-particle beams.** Channell, P.J. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 13p. (CONF-8608123—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001979.

From Advanced accelerator concepts conference; Madison, WI, USA (21 Aug 1986).

It is shown that laser focusing of high-energy charged-particle beams using the inverse Cherenkov effect is well suited for applications with large linear colliders. Very high gradient (>0.5 MG/cm) lenses result that can be added sequentially without AG cancellation. These lenses are swell understood, have small geometric aberrations, and offer the possibility of correlating phase and energy aberrations to produce an achromatic final focus.

7070 (LBL—22301) **Radio frequency phase in the FEL section of a TBA.** Kuenning, R.W.; Sessler, A.M.; Sternbach, E.J. (Lawrence Berkeley Lab., CA (USA)). Aug 1986. Contract AC03-76SF00098. 18p. (CONF-8608123—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001878.

From Advanced accelerator concepts conference; Madison, WI, USA (21 Aug 1986).

The basic idea of the two-beam accelerator is to have a low-energy beam travel through an undulator magnet and generate microwave radiation by the free electron laser mechanism. The energy of the low-energy beam is repeatedly resupplied by induction units, and the microwave radiation is employed to accelerate the desired particles to very high energies. The two-beam accelerator must incorporate in its free electron laser portion tight control of the rf wave amplitude and phase. With regards to this, the present paper extends many particle simulation to include non-equilibrium conditions and discusses several feedback systems to correct phase errors. A many-particle simulation is used to study the evolution of the radiation phase and amplitude, and results are compared with one-dimensional resonant particle analysis. The electric field evolution is also discussed. (LEW)

7071 **Beam intensity and position compensation circuits.** Chance, B.; Schick, D.; Hettel, R.; Powers, L. (Pennsylvania Univ., Philadelphia, USA. Inst. for Structural and Functional Studies; Pennsylvania Univ., Philadelphia, USA. Dept. of Biochemistry and Biophysics; Stanford Univ., CA, USA. Stanford Synchrotron Radiation Lab.; Bell Labs., Murray Hill, NJ, USA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **246**: No. 1-3, 400-403(15 May 1986). (CONF-850734—).

From 2. international synchrotron radiation instrumentation conference; Stanford, CA, USA (29 Jul 1985).

A high frequency mechanical modulator of photon beam intensity (vibrating reed) affords minimal obscuration of the beam, and precise measurements of beam intensity and position fluctuations. Corrections for the intensity fluctuations of the sample signal at 120 Hz by a wide band multiplier is demonstrated and possibilities for servo correction of sample position errors are indicated.

7072 **Hamiltonian systems in accelerator physics.** Laslett, L.J. (Lawrence Berkeley Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 1-8(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

General features of the design of annular particle accelerators or storage rings are outlined, and the Hamiltonian character of individual-ion motion is indicated. Examples of phase plots are presented, for the motion in one spatial degree of freedom, of an ion subject to a periodic nonlinear focusing force. A canonical transformation describing coupled nonlinear motion also is given, and alternative types of graphical display are suggested for the investigation of long-term stability in such cases.

7073 **Model equations for high-current transport.** Lee, E.P. (Lawrence Berkeley Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 61-66(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

The use of distribution functions to model transverse beam dynamics is discussed. Emphasis is placed on envelope equations, moments, the Vlasov equation, and the Kapchinski-Vladimirskij distribution.

7074 **Roundoff error in particle-orbit calculations.** Johnson, M.E.; Slaughter, A.J. (Fermi National Accelerator Lab., Batavia, IL, USA; Yale Univ., New Haven, CT, USA). *Particle Accelerators;* **19**: No. 1-4, 93-98(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

This paper analyzes the errors due to roundoff in kick-type accelerator tracking codes. We show that the error in the angle of the phase-space vector goes as m/sup 2/ and the error in magnitude goes as m, where m is the number of turns that a particle has been tracked. The latter is true only for small values of the kick term. This error is due entirely to the fact that because of roundoff errors, the determinant of the quadrupole transport matrix is not unity. This is demonstrated with a simple kick model of the Tevatron.

7075 **Tracking codes in accelerators: types and limitations.** Douglas, D.R. (Lawrence Berkeley Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 119-123(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

The motivation for tracking simulations of single-particle motion in circular accelerators is outlined. Three mathematical models, which are employed in many tracking programs describing charged-particle behavior, are presented, and the advantages and disadvantages of each model are discussed.

7076 **Effects of magnetic nonlinearities on a stored proton beam and their implications for superconducting storage rings.** Cornacchia, M.; Evans, L. (Lawrence Berkeley Lab., CA, USA; European Organization for Nuclear Research, Geneva, Switzerland). *Particle Accelerators;* **19**: No. 1-4, 125-144(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

An experiment is described which was conducted at the SPS to observe the combined effects of a single isolated high-order nonlinear resonance, nonlinear detuning, end tune modulation. The nonlinear resonance, as well as the nonlinear detuning, was driven by a nonlinear lens which had been previously used at the SPS for the study of beam-beam interactions. The nonlinear motion of a particle in the field of the lens is discussed.

7077 **Tests of orbital dynamics using the Tevatron.** Edwards, D.A.; Johnson, R.P.; Willeke, F. (Fermi National Accelerator Lab., Batavia, IL, USA; Deutsches Elektronen-Synchrotron, DESY, Hamburg, Germany, F.R.). *Particle Accelerators;* **19**: No. 1-4, 145-155(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

Measurements of Tevatron beam relevant to questions of orbital dynamics are described. General techniques and some preliminary results from phase-space-distortion experiments are presented.

7078 **Deprit's algorithm, Green's functions, and multiple perturbation theory.** Michelotti, L. (Fermi National Accelerator Lab., Batavia, IL, USA). *Particle Accelerators;* **19**: No. 1-4, 205-210(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

Within the context of accelerator multipole theory, we describe a method for solving Deprit's equations using a periodic Green's function. The procedure, implemented in a MACSYMA program, has been applied to a Hamiltonian with a normal sextupole term, and the 'averaged' or 'renormalized' Hamiltonian has been calculated to fourth order in sextupole strength. Anticommutativity of the bracket algebra explains the observed slow growth in the number of induced resonances with order.

## 4303 Auxiliaries And Components

*REFER ALSO TO CITATION(S) 6990, 7032, 7071, 7211*

7079 **(CONF-861114—21) Design for a high intensity slow positron facility using forward scattered radiation from an electron linear accelerator.** Hulett, L.D. Jr.; Lewis, T.A.; Alsmiller, R.G. Jr.; Peelle, R.; Pendyale, S.; Dale, J.M.; Rosseel, T.M. (Oak Ridge National Lab., TN (USA); State Univ. of New York, Fredonia (USA). Dept. of Physics). 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002177.

From 9. international conference on application of accelerators in research and industry; Denton, TX, USA (10 Nov 1986).

A tungsten moderator will be placed behind the target of the Oak Ridge Electron Linear Accelerator (ORELA) to convert gamma radiation to slow positrons. These will be extracted and led through evacuated solenoids to an experiment room. A Penning trap will be used to extend the slow positron pulses to achieve duty factors of 10% or greater. The facility will be used for atomic and molecular physics studies, positron microscopy, and materials research. Operations will be inexpensive and will not interfere with the normal function of ORELA, the measurement of neutron cross sections by flight-time spectrometry.

7080 (DOE/ER/40238—1, pp 3427-3429) **Photoneutron source based upon an electromagnetic undulator.** Steinbach, A. (Oregon Applied Research, Beaverton). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The following points are made: First, if one is interested in obtaining (without moderation) low-energy neutrons in the energy range of say 0-100 eV, then the reaction $Be^9 + \gamma \rightarrow Be^8 + n$ 1.664 MeV is of no interest. Rather, one should concentrate on the reaction $H^2 + \gamma \rightarrow H^1 + n$ - 2.224 MeV. Second, if as a result of future advances in accelerator technology it becomes possible to produce intermediate energy (E~1 GeV), high current electron beams with both very high energy purity, and low divergence, then it should be possible to produce MeV photon beams with similarly outstanding properties (as regards energy purity and angular divergence) by passing the electron beam through an electromagnetic undulator consisting of a high-power, pulsed wave of $CO_2$ laser radiation travelling counter to the electron beam. And third, such a narrow-band, highly-directional photon beam - when tuned to the proper energy above the photonuclear reaction threshold - should permit the generation of low-energy neutrons having a high degree of correlation between energy and angle of emission, provided that this correlation is not destroyed by the irreducible zero-point motion of the target atoms.

7081 (DOE/ER/40238—1, pp 3430-3432) **Breeding new light into old machines (and new).** Spencer, J.E.; Brodsky, S.J. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Photons produced by lasers or wigglers backscattered on high energy electron or proton beams can provide high energy, high luminosity photon-electron, photon-photon or photon-proton collisions. This allows the study of short-distance QCD processes such as high transverse momentum photon-photon and photo-production reactions, deep inelastic Compton scattering, the photon structure function, direct photon reactions, or searches for pseudo-Goldstone bosons and supersymmetry particles like the photino or goldstino. The relative reaction rates should be quite high since (1) photo-production cross sections are significantly larger than the corresponding electroproduction cross sections and (2) absence of the conventional beam-beam interaction allows significantly higher currents and smaller interaction areas. It thus seems possible to have photon luminosities much larger than for electrons. Examples are given using the PEP storage ring with the SLAC linac beam.

7082 (DOE/ER/40238—1, pp 3557-3561) **Operation of large cryogenic systems.** Rode, C.H.; Ferry, B.; Fowler, W.B.; Makara, J.; Peterson, T.; Theilacker, J.; Walker, R. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

This report is based on the past 12 years of experience on R & D and operation of the 27 kW Fermilab Tevatron Cryogenic system. In general the comments are applicable for all helium plants larger than 1000W (400 l/hr) and non mass-produced nitrogen plants larger than 50 tons per day.

7083 (DOE/ER/40238—1, pp 3562-3564) **Recent advances in the technology of superconducting accelerator magnets.** Taylor, C.E. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Recent progress in technology of high-current density cables for SSC model magnets is summarized. NbTi cable with J/sub c/ up to 50% higher than Tevatron cable can be expected. Magnetization effects can be predicted and corrected with several new techniques. Development of Superconductor with 2-3 μm filament diameter and high J/sub c/ is expected.

7084 (DOE/ER/40238—1, pp 3565-3569) **Recent progress in RF superconductivity.** Piel, H. (Univ. of Wuppertal, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The wide spread activities to prepare major size superconducting accelerating systems mainly for the large storage rings presently under construction in Europe and Japan are based on the continuous progress in RF superconductivity achieved in the past years. The thermal stability of s.c. cavities has been increased significantly by improving the thermal conductivity of niobium with different techniques. The promising attempts to sputter high purity niobium onto 500 MHz copper cavities have shown encouraging results. Multicell cavities at 3 GHz coated with $Nb_3Sn$ achieved high Q values already at 4.2 K. Field emission studies using modern surface analytical tools are shedding more light on anomalous electric surface breakdown fields. This report summarizes briefly the current activities in different laboratories and comments on recent achievements with superconducting cavities and in materials research.

7085 (DOE/ER/40238—1, pp 3581-3583) **Abort kicker power supply systems at Fermilab.** Krafczyk, G.; Dugan, G.; Harrison, M.; Koepke, K.; Tilles, E. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Over the past several years, Fermilab has been operating with a single turn proton abort system in both the superconducting Tevatron and the conventional Main Ring. The abort kicker power supply for this system discharges a lumped capacitance into the inductive magnet load, causing the beam to enter the abort channel. A unique feature of this design is the high voltage, high current diode assembly used to clip the recharge of the capacitor bank. This allows the current to decay slowly with the L/R time constant of the magnet and diode series combination. Special attention will be given to the diode characteristics needed for this passive switching element. Operational experience and proposed upgrades will be given for the two operational systems.

7086 (DOE/ER/40238—1, pp 3584-3585) **Novel fabrication technique for thin metallic vacuum chambers with low eddy current losses.** Kouptsidis, J.; Banthau, R.; Hartwig, H. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Eddy current problems in synchrotrons have been avoided until now by using costly and thick ceramic vacuum chambers which reduce the free magnet aperture. These disadvantages are eliminated by a novel fabrication technique developed for the chambers of the new 9 GeV electron synchrotron DESY II operating with 12.5 Hz repetition rate. The elliptical chambers 80 x 40 mm are made from .3 mm thick stainless steel tubes reinforced by thin ribs. The ribs are brazed on the tubes by a high temperature Ni-base brazing alloy. The linear eddy current losses are 60 W/m and increase the chamber temperature to only 50°C. The available beam aperture is now 93% of the magnet gap. A still higher repetition rate up to 100 Hz can be achieved by reducing the wall thickness to .1 mm and using tubes made from a Ti-alloy having higher resistivity than stainless steel.

7087 (DOE/ER/40238—1, pp 3590-3592) **Superconducting half-wave for accelerating high velocity ions.** Delayen, J.R.; Mercereau, J.E. (California Institute of Technology, Pasadena). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A computer model for the design of superconducting resonators has been developed which includes feedback effects due to non-linear superconducting surface resistance. These non-linearities may be due to either magnetic field or temperature. The authors have utilized this model to optimize the design of accelerating resonators for heavy ions. A half-wave structure of this design has been fabricated and is being evaluated with respect to the parameters of the model. Preliminary experimental results agree with the model to within a few percent. The half-wave design is particularly well suited to high frequency, high $\beta$ resonators because of its low magnetic field, or to low frequency, very low $\beta$ resonators because of its good mechanical stability.

7088 (DOE/ER/40238—1, pp 3593-3595) **Azimuthal shaping of cylindrical accelerating cavities for improved higher order mode extraction.** Amato, J.C.; Coulombe, D.; Kirchgessner, J.L.; Sundelin, R.M. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In cylindrically symmetric accelerator cavities equipped with higher order mode (HOM) couplers, the two polarizations of each deflecting mode are often fixed by the couplers themselves, leaving one polarization inadequately damped. This problem can be overcome by deliberate breaking of the cell's cylindrical symmetry. The authors describe a quasi-cylindrical cavity profile in which the polarization of the dipole, quadrupole, and sextupole HOM's are fixed at $+/-\pi/4$, $+/-\pi/8$, $+/-\pi/12$ with respect to the intended coupler orientation, providing a maximally favorable situation for damping by a single coupler. A single cell S-band cavity was built to test the practicality of their design. The experimental data, in the range 3-7 GHz, conclusively shows that the mode polarizations can be controlled with only minor perturbations to the cell's cylindrical symmetry.

7089 (DOE/ER/40238—1, pp 3599-3601) **Design and test of a superconducting quarter-wave-resonator.** Steck, M.; Grieser, M.; Jaeschke, E.; Kraemer, D.; Repnow, R.; Sailer, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A superconducting quarter-wave-resonator at 325 MHz has been designed that could be used as a debuncher for the Heidelberg postaccelerator. The design study utilized the computer codes SUPERFISH and URMEL as well as a theory considering the quarter-wave-resonator as a piece of transmission line shorted at one end. These calculations were used to optimize H/sub p/epsilon/sub acc/, E/sub p//epsilon/sub acc/ and U/epsilon/sub acc/$^2$. According to measurements with a model resonator the copper body of a first prototype resonator has been machined. In first experiments with an electrochemically plated lead surface an unloaded quality and accelerating field have been measured.

7090 (DOE/ER/40238—1, pp 3602-3604) **Superconductors for pulsed RF accelerators.** Campisi, I.E.; Farkas, Z.D. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The choice of superconducting materials for accelerator RF cavities has been determined in the past only in part by basic properties of the superconductors, such as the critical field, and to a larger extent by criteria which include fabrication processes, surface conditions, heat transfer capabilities and so on. For CW operated cavities the trend has been toward choosing materials with higher critical temperatures and lower surface resistance, from Lead to Niobium, from Niobium to $Nb_3Sn$. This trend has been dictated by the specific needs of storage ring CW system and by the relatively low fields which could be reached without breakdown. The work performed at SLAC on superconducting cavities using microsecond long high power RF pulses has shown that in Pb, Nb, and $Nb_3Sn$ fields close to the critical magnetic fields can be reached without magnetic fields can be reached without magnetic breakdown. The new picture of the short-pulse, peak field properties of the superconductors tested so far, together with the special needs of the pulse superconducting systems, has led us to reevaluate the parameters of superconducting cavities which are of importance in

this context and to reconsider which material would be best suited for pulse power applications.

7091 (DOE/ER/40238—1, pp 3605-3607) **Lead alloys for superconducting cavities.** Dietl, L.; Rieger, K.; Trinks, U. (Universitaet Muenchen, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

For the superconducting separated orbit cyclotron Tritron six large, wedge shaped cavities for simultaneous acceleration of 19 parallel ions beams are needed. The indirectly cooled superconducting cavities with frequencies of ~170 MHz +/- 3 % will be made of copper electroplated with lead alloy. With PbSn and PbBi as superconductor stable surfaces without chemical polishing can be obtained. The results of measurements on a 500 MHz test cavity (PbSn) are reported.

7092 (DOE/ER/40238—1, pp 3607-3609) **Superconducting resonators for the University of Washington booster linac.** Storm, D.W.; Brennan, J.M.; Ben-Zvi, I. (Univ. of Washington, Seattle). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors have developed two models of a 150 MHz quarter wave resonator - one with optimum beta = 0.10 and one with optimum beta = 0.21. These are lead-plated copper structures. The prototype beta- = 0.10 resonator was tested successfully a year ago and gave average accelerating fields of 3.5 MV/m with 4.2 Watts dissipated. The authors have made and tested several more of this model. A prototype beta = 0.21 resonator has been completed, but weld flaws have prevented definitive tests. In order to minimize surface electric fields in the high-beta resonator, there were some modifications in the drift tube shape beyond those required to change the optimum beta. These quarter wave resonators have a wide transit time factor curve and are extremely rigid mechanically. Variations in eigen-frequency due to mechanical vibrations are less than 1 Hertz. Maximum attainable fields are limited by field emission.

7093 (DOE/ER/40238—1, pp 3610-3612) **Superconducting $Nb_3Sn$ coated multicell accelerating cavity.** Peiniger, M.; Piel, H. (Univ. of Wuppertal, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors report on the first results, obtained with a five cell $Nb_3Sn$ coated accelerating structure of 3 GHz. A uniform layer of $Nb_3Sn$ was formed by processing a niobium structure in a tin atmosphere at 1170°C. At 4.2 K a resonator Q of $7 \times 10^9$ was measured. This corresponds to a residual surface resistance of 27 nOmega which is the lowest ever achieved with a $Nb_3Sn$ cavity in the GHz range. The RF losses of this resonator are by a factor of 55 lower than those of an equivalent niobium cavity at 4.2 K. The maximum accelerating field at this temperature was 4.0 MV/m. It is similar to the quench field of the niobium structure before coating. The spatial distribution of the RF losses was measured at different field levels using the temperature mapping technique. The authors describe the characteristic features of the $Nb_3Sn$ layer, they report on residual losses specific to $Nb_3Sn$ coated niobium structures and they discuss the observed field limitations.

7094 (DOE/ER/40238—1, pp 3613-3615) **Large aperture pulsed septum magnet for antiproton injection into the CERN AC ring.** Pearce, P.; Sherwood, T.R.; Bruinsma, P.J.T.; Rookhuizen, H.B.; Vogel, A. (CERN, Geneva, Switzerland). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A new collector ring (AC) is being built around the existing Antiproton Accumulator (AA) machine in order to increase the accumulation rate of antiprotons. A much larger fraction of the particles produced at an improved target station will be transported to AC with a new 3.5 GeV/c beam line. This increased flux will be injected using a large aperture pulsed septum magnet capable of handling the 240 $\pi$.mm.mrad transverse emittances. Because the antiproton beam traverses the septum gap in air no vacuum problems arise and consequently the magnet can be of simple, glued construction. The beam requirements together with some of the unusual engineering design features of the 1.6 m long, 1 Tesla curved septum magnet are discussed.

7095 (DOE/ER/40238—1, pp 3616-3618) **Magnetic field computations of fringe fields between a dipole and a quadrupole magnet.** Rinolfi, L.; Preis, K.; Richter, K.H.; Stoegner, H. (CERN, Geneva, Switzerland). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The aim of this paper is to present the results, of 3-D calculations, on the interferences between a dipole and a quadrupole magnet in the CERN Antiproton Collector lattice. The results of the computation show errors which are very small and while it is necessary to correct them, this is within the range of correction techniques by shimming used to linearise the field. One obvious improvement might be a full three dimension model of an excited neighboring magnet.

7096 (DOE/ER/40238—1, pp 3622-3624) **Magnetic field measurements of the DESY II magnets.** Berghaus, U.; Kriens, W.; Paetzold, S. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A new method has been developed for the precise magnetic field measurements in ac magnets. The technique has been applied to the DESY II dipoles and quadrupoles. Movable coils of various lengths are used, and voltage induced by the ac excitation is compensated by reference coil. A fast ADC triggered at different levels of magnet current converts the output of a low drift analogue integrator. Measurement and data handling are microprocessor controlled. The data are sent to the computer center for analysis and storage. From there the results and a graphic display are sent back to a local interactive terminal for qualitative online checking.

7097 (DOE/ER/40238—1, pp 3625-3627) **Design, construction and performance of the DESY II magnets.** Hemmie, G.; Berghaus, U.; Boettcher, H.; Dasskowski, E.; Heller, H.R.; Meyer, G.; Nawrath, G.; Schwickert, F.; Sinram, K.; Woebke, G.; Wuempelmann, H. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Dipoles, quadrupoles and sextupoles have been designed and constructed for the new separated function synchrotron, DESY II. The special constraints for the magnets were: 12.5 Hz repetition frequency and a 50 MeV to 10 GeV energy operation range. Special care was taken in selecting the steel, choosing the thickness of laminations and designing the endfield shape. To ensure easy access to the vacuum chamber, and because there are nine inlet and outlet beam pipes to be installed, a c-type pole shape design for the dipole was chosen. The quadrupoles and sextupoles have the same cross section as the PETRA magnets, but they are different in length, lamination thickness, coils and endfield shape. Back-leg windings are applied on the dipoles to enable horizontal orbit displacements to be made. The major part of the vertical orbit correction will be made using four coils mounted on the return yokes of the sextupoles so as to create superimposed horizontal magnetic fields.

7098 (DOE/ER/40238—1, pp 3628-3630) **Pulsed septum magnet for the Fermilab antiproton source.** Satti, J.A.; Holmes, S.D. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 2 meter curved pulsed septum magnet for use in the Fermilab Antiproton Source is described. The magnet produces a peak field of 6 kGauss at a current of 20,000 Amperes within a 0.4 msec long pulse. The field uniformity obtained is $\delta B/B < 0.2\%$ out to 3.8 cm from the copper septum. Power enters the magnet from the center resulting in very simple ends and the magnet incorporates a 0.5 cm steel guard which reduces the field to < 1.4 Gauss in the zero-field region. The total septum thickness is 1.3 cm. The vacuum enclosure doubles as the stacking fixture for the magnet laminations allowing easy assembly of a magnet with a 50 m radius of curvature.

7099 (DOE/ER/40238—1, pp 3631-3633) **Magnets for the German spallation source SNQ.** Bechstedt, U.; Haas, H.; Hacker, U.; Hardt, A.; Henn, K.; Martin, S.; Wimmer, J. (SNQ/ABT of the KFA-Juelich, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

For the SNQ high energy linac 320 quadrupoles with a gradient of up to 6 T/m and a bore of 80 mm will be used. The design and mechanical layout of a cheap prototype are presented. The coils with a low resistivity and a high filling factor are produced by simply sawing from a forged hollow copper block. Due to radiation exposure no organic materials are used and insulation is established by spacers and distance. Design criteria and layout of the beam line and the tolerances are discussed.

7100 (DOE/ER/40238—1, pp 3634-3636) **Ferrite kicker magnet for the LAMPF switchyard upgrade.** Hardekopf, R.A.; Higgins, E.F.; Lunsford, J.S. (Los Alamos National Lab., NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The new LAMPF switchyard requires a kicker magnet as the first element in the transport line leading to the Proton Storage Ring (PSR). The magnet must produce 1-ms-long pulses with 40-μs rise time and < 0.3% flat-top regulation to deflect the 800-MeV $H^-$ beam by 1.2°. The authors have constructed two 1-m-long, single-turn ferrite magnets, each powered by a modulator supplying up to 2400 A at a maximum rate of 24 Hz. The modulators use a transistor amplifier/regulator, a dual pulse-forming-network (PFN), and a compensating circuit driven by a function generator to achieve a total 0.1% current variation in the pulse. The system also produces an alternate kicking mode consisting of 150-μs-long pulses at a maximum rate of 120 Hz; the two modes can be multiplexed within the charging power-supply limitations.

7101 (DOE/ER/40238—1, pp 3637-3639) **Measurement and resulting first and second order approximations for a 9 degree bending magnet in LAMPF's 750-keV transport.** Hurd, J.W. (Los Alamos National Lab., NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The three Cartesian components of magnetic field are measured for a 9 degree bending magnet. Measurement errors are corrected and the data is fit to a polynomial which satisfies Maxwell's equations. Particle paths through the magnet are calculated by numerical integration and the corresponding first and second order particle transformation matrices are generated. A parameterization for the first order transformation matrix is developed and the resulting approximations for predicting particle motion in the magnet are compared to the results of the numerical integration.

7102 (DOE/ER/40238—1, pp 3640-3642) **CSEM-Steel hybrid wiggler/undulator magnetic field studies.** Halbach, K.; Hoyer, E.; Marks, S.; Plate, D.; Shuman, D. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract W-7405-ENG-48.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Current design of permanent magnet wiggler/undulators use either pure charge sheet equivalent material (CSEM) of the CSEM-Steel hybrid configuration. Hybrid configurations offer higher field strength at small gaps, field distributions dominated by the pole surfaces and pole tuning. Nominal performance of the hybrid is generally predicted using a 2-D magnetic design code neglecting transverse geometry. Magnetic measurements are presented showing transverse configuration influence on performance, from a combination of models using CSEMs, REC (H/sub c/ = 9.2 kOe) and NdFe (H/sub c/ = 10.7 kOe), different pole widths and end configurations. Results show peak field improvement using NdFe in place of REC in identical models, gap peak field decrease with pole width decrease (all results less than computed 2-D fields), transverse gap field distributions, and importance of CSEM material overhanging the poles in the transverse direction for highest gap fields.

7103 (DOE/ER/40238—1, pp 3643-3645) **Hybrid rare earth quadrupole drift tube magnets.** Halbach, K.; Feinberg, B.; Green, M.I.; MacGill, R.; Milburn, J.; Tanabe, J. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A prototype quadrupole permanent magnet with adjustable field strength has been constructed and tested. The magnet consists of iron pole pieces to provide the required field shape along with rare earth permanent magnet material (samarium cobalt) to energize the magnet. A unique feature of the configuration is the adjustability of the field by rotating the outer rings consisting of permanent magnets and iron. Magnetic tests show small field errors coming from well understood assembly details. Mechanical tests show the design needs further consideration to ensure reliability. It is planned to use this type of magnet in the SuperHILAC prestripper drift tubes.

7104 (DOE/ER/40238—1, pp 3646-3647) **Design of a three channel septum magnet.** Milburn, J.; Porter, J.; Tanabe, J.; Caylor, R.; Reimers, R. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A three channel septum magnet has been designed to service the three primary beam lines at the exit of the SuperHILAC. A pulsed switching magnet located in the next to last drift tube in the SuperHILAC poststripper diverts the beam +/- 1.09° into either the north or south port of the septum magnet. The central channel allows an undiverted beam to pass into another distribution magnet downstream. All channels may be active simultaneously and each may be tuned independently. Each septum channel contains four separate field regions and bends the beam 14.91°. Various important aspects of the design, including geometry, material selection, thermal characteristics and power requirements, are discussed.

7105 (DOE/ER/40238—1, pp 3648-3650) **End magnets for the NBS-Los Alamos racetrack microtron.** Debenham, P.H.; Lindstrom, E.R.; Mohr, D.L. (National Bureau of Standards, Gaithersburg, MD). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Two end magnets have been designed and constructed for the 185 MeV NBS-Los Alamos racetrack microtron. The field has been measured in the first magnet and is uniform over a 0.62 $m^2$

area to within +/- 2 x $10^{-4}$ at 1 T. The magnet meets all performance specifications. Field measurements are underway on the second magnet. In this paper, design and construction details which play an important role in magnetic performance are described, and the measured fields are compared with calculations.

7106 (DOE/ER/40238—1, pp 3651-3653) **High and ultra-high gradient quadrupole magnets.** Brunk, W.O.; Walz, D.R. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Small bore conventional dc quadrupoles with apertures from 1 to 2.578 cm were designed and prototypes built and measured. New fabrication techniques including the use of wire electric discharge milling (EDM) to economically generate the pole tip contours and aperture tolerances are described. Magnetic measurement data from a prototype of a 1 cm aperture quadrupole with possible use in future $e^+/e^-$ super colliders are presented. At a current of 400A, the lens achieved a gradient of 2.475 T/cm, and had an efficiency of 76.6%.

7107 (DOE/ER/40238—1, pp 3654-3656) **TOSCA calculations and measurements for the SLAC SLC damping ring dipole magnet.** Early, R.A.; Cobb, J.K. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The SLAC damping ring dipole magnet was originally designed with removable nose pieces at the ends. Recently, a set of magnetic measurements was taken of the vertical component of induction along the center of the magnet for four different pole-end configurations and several current settings. The three dimensional computer code TOSCA, which is currently installed on the National Magnetic Fusion Energy Computer Center's Cray X-MP, was used to computer field values for the four configurations at current settings near saturation. Comparisons were made for magnetic induction as well as effective magnetic lengths for the different configurations.

7108 (DOE/ER/40238—1, pp 3657-3659) **SLC arc transport system - magnet design and construction.** Fischer, G.E.; Anderson, M.; Byers, R.; Halbach, K. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

This paper describes design and construction details and alternate gradient bending magnets, 950 of which are used in a single pass transport system to bring high energy positrons and electrons into head-on collision. The overall arc system is 8000 ft. long, has an aperture of 1/2" and circumference factor of 96%.

7109 (DOE/ER/40238—1, pp 3660-3662) **SLC arc transport system-ag-magnet measurement and performance.** Weng, W.T.; Anderson, M.; Byers, R.; Cobb, J.; Fischer, G.; Hamilton, V. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

This paper describes the design, construction, and operation of devices used to rapidly measure the mechanical and magnetic properties of some 950 Alternate gradient magnets used in the arc system of the Stanford Linear Collider. The problems of dealing with the measurement of the transverse dimensions to within minute (0.0001 in) resolution of objects that are 8 ft long are discussed. Early results from the production runs of these magnets are presented.

7110 (DOE/ER/40238—1, pp 3663-3665) **Coupled vibrational modes of the SLC Arc magnet and support system.** Weng, W.T.; Chao, A.W. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The magnet support system for the SLC Arcs will be a long series of pedestals with each pedestal supporting the ends of two adjacent magnets. It has been pointed out by several authors that random magnet vibrations in the Arc with amplitudes larger than 0.1 rms are potentially harmful for the SLC operation. In order to assess the vibrational behavior of the Arc magnet system, the authors need to understand: (1) the sources and characteristics of the ground disturbances, (2) the coupled vibrational modes of the composite pedestal-magnet system and, (3) the response of the system to ground disturbance. This note is an attempt to study item (2).

7111 (DOE/ER/40238—1, pp 3666-3668) **Some uses of REPMM's in storage rings and colliders.** Spencer, J.E. (Stanford Linear Accelerator Center, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Improvements for existing rings and techniques for building new rings composed entirely of passive, Rare Earth Permanent Magnet Multipoles (REPMM's) are considered using circular dipoles, quadrupoles and sextupoles. Over the past few years the authors have made such magnets using a single size $SmCo_5$ block with up to five easy-axis orientations. The final production scheme is modular in that magnets are built-up from quantized layers. All multipole layers are made in exactly the same way using algorithms differing only by the desired multipole symmetry. The method is simple, efficient and inexpensive and allows a do-it-yourself approach to constructing new magnetic elements. For rings these might include focusing optical klystrons, rotatable multipoles for diagnostics, correction or extraction, or possibly combined function systems for the unit cells. A high quality, low-beta, PMQ insertion which can change beta, tune and energy is described as well as the PMS's for the SD and SF elements of the North SLC damping ring. Because these sextupoles will be the first optical use of PM's in storage rings they are discussed in detail together with the advantages, problems and requirements of such applications.

7112 (DOE/ER/40238—1, pp 3669-3671) **Radiation effects of protons on samarium-cobalt permanent magnets.** Blackmore, E.W. (TRIUMF, Vancouver, British Columbia). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

At TRIUMF the use of samarium-cobalt permanent magnet quadrupoles as the first element in a secondary channel has been studied as a means of increasing the solid angle acceptance of the channel. The high remanant induction B/sub r/ and high coercive force H/sub c/ of rare-earth cobalt (REC) can be utilized to produce a high-gradient quadrupole field in an extremely compact magnet. Although many properties of REC material have been measured, little is known about the effect of charged particle radiation on the magnetic behavior. As the TRIUMF application requires the magnets to operate in a high radiation environment it was considered essential to study this effect. This paper describes the results of exposing samples of samarium-cobalt and other permanent magnet materials to a beam of protons.

7113 (DOE/ER/40238—1, pp 3672-3674) **Stress relaxation studies of CBA and SSC coil sections.** Anerella, M.; Hoffman, A.; Jackimowicz, R.; Lenz, W.; Skaritka, J.; Tuttle, D. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Instrumented fixtures were built to measure coil assembly stress and relaxation rates in samples of CBA and SSC coil sections. The effects of constant temperature and thermal cycling on short and long term relaxation are presented. Conclusions and suggestions are presented to achieve minimum long term stress relaxation during the assembly and installation of the SSC rings.

7114 (DOE/ER/40238—1, pp 3675-3677) **Performance of four 4.5 m two-in-one superconducting R & D dipoles for the SSC.** Dahl, P.; Cottingham, J.; Fernow, R.; Garber, M.; Ghosh, A.; Goodzeit, C.; Greene, A.; Herrera, J.; Kahn, S.; Kelly, E.; Morgan, G. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Four 4.5 m long superconducting dipoles built to specifications similar to those for SSC Reference Design A have been successfully tested. They were wound with NbTi cable in two-layer cos theta coils of 3.2 cm inner diameter. The coil ends were flared to increase the minimum bending radius, anticipating coils wound from prereacted $Nb_3Sn$. The coils were mounted in a reusable two-in-one iron yoke prestressed by means of a bolted stainless steel shell. The first two magnets as well as the fourth one, a special magnet designed to study cross-talk between the bores, used CBA/Tevatron cable. The third utilized cable with improved (high homogeneity) NbTi conductor. All four reached central fields corresponding to their short sample limits at 4.5 K without training nearly 6.0T for the first two magnets, 6.5T for the third, and 5.4T for the fourth. At 2.5K modest training was required to reach short sample limits of 7.2T, 7.1T, 7.8T, and 6.6T respectively. The measured values of the allowed harmonics were within several x $10^{-4}$ of the calculated ones.

7115 (DOE/ER/40238—1, pp 3678-3680) **Results from heater-induced quenches of a 4.5 m two-in-one superconducting R & D dipole for the SSC.** Ganetis, G.; Prodell, A. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Quench studies were performed using a 4.5 m long SSC R & D dipole to determine the temperature rise during a quench by measuring the resistance of the conductor cable in the immediate vicinity of the quench. The 2-in-1 magnet was wound with improved high homogeneity NbTi conductor in a 2-layer cosine Theta coil configuration of 3.2 cm inner diameter with each layer powered separately to simulate graded conductor. Twelve pairs of voltage taps were installed at various locations in the coils around one bore of the magnet. Spot heaters were placed between the voltage taps of 8 of these pairs to initiate magnet quenches. The resistance of the conductor was obtained from observations of the current and voltage during a magnet quench. The temperature of the conductor was then determined by comparing its resistance to an R vs T curve measured independently for the conductor.

7116 (DOE/ER/40238—1, pp 3681-3683) **Effect of $Cu_4Ti$ compound formation on the characteristics of NbTi accelerator magnet wire.** Garber, M.; Suenaga, M.; Sampson, W.B.; Sabatini, R.L. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

High critical current density, J/sub c/ > 2500 A/mm², and small filament diameter, d ~ 3 μm, are required in multifilamentary NbTi wire used for superconducting accelerator magnets. Wires obtained from various commercial sources had J/sub c/'s in the range 1000 to 2800 A/mm² and d's in the range 1 to 23 μm. The filaments were examined by means of scanning electron microscopy in order to determine the reason for the variation in J/sub c/. It was found that the filaments in high J/sub c/ wires had clean smooth surfaces and uniform cross section along their lengths. Filaments in low J/sub c/ wires show formation of $Cu_4Ti$ compound particles on their surfaces and large variations in cross section. The lower critical current measured in these wires is believed to be largely due to this effect. The superconducting-normal state transition is relatively wide in these wires.

7117 (DOE/ER/40238—1, pp 3684-3686) **Magnetization, critical current, and injection field harmonics in superconducting accelerator magnets.** Ghosh, A.K.; Sampson, W.B.; Wanderer, P. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The very large energy ratio of machines such as the SSC dictates rather low injection field (for 6T, 20 TeV it is approximately 0.3T). Since the harmonic content at such low fields is largely determined by magnetization currents in the superconductor, the random errors depend on the uniformity of the superconducting wire. In principle the magnitude of the residual fields can be reduced indefinitely by using finer filaments, but in practice there is a lower limit of a few microns. The authors compared the injection field harmonics for a number of accelerator dipoles with magnetization measurements made on samples of the conductor used to wind the coils. In addition both the magnetization and harmonics have been compared with short sample critical current measurements made at 5T. The results indicated that an accurate estimate of the variation in injection field harmonics can only be obtained from direct measurements of the magnetization of the cable. It appears feasible to use such measurements to shuffle magnets for a large accelerator by predicting the low field properties of a magnet before actually winding the coils.

7118 (DOE/ER/40238—1, pp 3687-3688) **Design for a high field combined function superferric magnet.** Gupta, R.C.; Morgan, G.H. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A combined function superferric magnet option has been investigated for the Relativistic Heavy Ion Collider (RHIC). The option requires the maximum value of the field in the magnet to be much higher than that achieved in any existing combined function accelerator magnet. A model is presented here in which a good field quality can be maintained up to 2T. It is done by carefully designing the yoke structure and positioning the coils in such a way that the iron poles tend to saturate evenly across the gap. A cold iron model might be necessary for this magnet.

7119 (DOE/ER/40238—1, pp 3689-3691) **Random errors in the magnetic field coefficients of superconducting magnets.** Herrera, J.; Hogue, R.; Prodell, A.; Wanderer, P.; Willen, E. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Random errors in the multipole magnetic coefficients of superconducting magnet have been of continuing interest in accelerator research. The Superconducting Super Collider (SSC) with its small magnetic aperture only emphasizes this aspect of magnet design, construction, and measurement. With this in mind, the authors present a magnet model which mirrors the structure of a typical superconducting magnet. By taking advantage of the basic symmetries of the dipole magnet, they use this model to fit the measured multipole rms widths. The fit parameters allow us then to predict the values of the rms multipole errors expected for the SSC dipole reference design D, SSC-C5. With the aid of first-order perturbation theory, the authors then give an estimate of the effect of these random errors on the emittance growth of a proton beam stored in an SSC.

7120 (DOE/ER/40238—1, pp 3692-3694) **Comparison of magnetic field calculations to measurements on a CBA 2-in-1 magnet system.** Kahn, S.; Gupta, R.; Morgan, G.; Thompson, P. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The CBA 2-in-1 dipole magnet provides a complex system to test field calculation techniques. In particular the quadrupole term in one half of the magnet induced by the operation of the other half of the magnet is studied. A comparison with field measurement data is made for calculated magnetic field harmonics as a function of current for symmetric and asymmetric operations of the two sides of the magnets. The calculations are made using both differential equation solving programs (PE2D, POISSON) and integration based programs (GFUN). These programs are compared to each other and to the measured data.

7121 (DOE/ER/40238—1, pp 3695-3697) **Use of an elliptical aperture to control saturation in closely-coupled, cold iron, superconducting dipole magnets.** Morgan, G.. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The high fields permitted by superconducting windings result in saturation of closely-coupled iron in dipole and quadrupole beam transport magnets. Coupland suggested using a triangular cutout at the poles to reduce the change in the sextupole ($b_2$) term due to saturation. The use of an elliptical aperture in a close-coupled dipole for the Relativistic Heavy Ion Collider (RHIC) has been studied using the BNL computer program MDP (a version of GFUN). The ellipse aspect ratio was varied while holding the horizontal (minor) radius constant. The proper aspect ratio gives no shift in $b_2$ due to saturation, and a reduction in the $b_4$ shift. A modification of the ellipse also reduces $b_4$. The elliptical aperture introduces a large $b_2$ term at low field which must be compensated for by the coil design. A practical coil design which does this for the RHIC magnet is presented.

7122 (DOE/ER/40238—1, pp 3698-3700) **Superconducting magnet system for RHIC.** Thompson, P.A.; Cottingham, J.; Dahl, P.; Fernow, R.; Garber, M.; Ghosh, A.; Goodzeit, C.; Greene, A.; Hahn, H.; Herrera, J.; Kahn, S. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The proposed Relativistic Heavy Ion Collider (RHIC) will operate at ion energies of 7 to 100+ GeV/Amu for ions as heavy as $Au^{197}$. This paper discusses the superconducting magnet system for this machine. It will consist of 372 dipoles typically 9.7 meters long with an operating field of 3.4 Tesla, 492 quadrupoles with typical length 1.4 meters, gradient 76 T/m, and approximately 1000 sextupole and corrector magnets. A detailed design has been developed for the dipoles which will have a clear bore of 76 mm; less detailed designs are presented for the other components. A proof-of-concept magnet has been constructed and successfully tested.

7123 (DOE/ER/40238—1, pp 3701-3703) **5 m long impregnated NbTi dipole magnet.** Leroy, D.; Castiglioni, M.; Hagedorn, D. (CERN, Geneva, Switzerland). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 5 m long superconducting dipole designed as an accelerator magnet has been constructed and tested at CERN. A bore field Bo = 4.2 T - and integrated field of 23 Tm - in a 7 cm aperture has been obtained without training. Description of the magnet and measurements are given.

7124 (DOE/ER/40238—1, pp 3707-3709) **High gradient superconducting quadrupoles.** Lundy, R.A.; Brown, B.C.; Carson, J.A.; Fisk, H.E.; Hanft, R.H.; Mantsch, P.M.; McInturff, A.D.; Remsbottom, R.H. (Fermi National Accelerator Center, Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00515.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Prototype superconducting quadrupoles with a 5 cm aperture and gradient of 16 kG/cm have been built and tested as candidate magnets for the final focus at SLC. The magnets are made from NbTi Tevatron style cable with 10 inner and 14 outer turns per quadrant. Quench performance and multipole data are presented. Design and data for a low current, high gradient quadrupole, similar in cross section but wound with a cable consisting of five insulated conductors are also discussed.

7125 (DOE/ER/40238—1, pp 3710-3713) **Experimental evaluation of design features of a cryostat for an iron-less cos theta SSC magnet.** Niemann, R.C.; Carson, J.A.; Engler, N.H.; Fisk, H.E.; Gonczy, J.D.; Hanft, R.H.; Kuchnir, M.; Mantsch, P.M.; Mazur, P.O.; McInturff, A.D. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A conceptual design for an iron-less cos theta SSC magnet cryostat has identified several areas for experimental study. Included are bowing of thermal radiation shields due to cooldown and warmup; thermal performance of the suspension systems; cryostat thermal performance; structural responses to decentering forces between the coil and the steel vacuum vessel; and response of thermal shields to forces due to quench induced eddy currents. Studies were carried out with 6 m long thermal bowing and magnetic effects models, a suspension heat leak measurement dewar and a 12 m long thermal model. The models incorporate important features of the conceptual cryostat design. The details of the test arrangements, procedures and results are presented.

7126 (DOE/ER/40238—1, pp 3714-3716) **Superconducting wire with small filaments for SSC magnets.** Tanaka, Y.; Ikeda, M.; Tanaka, H. (Furukawa Electric Co., Ltd., Tokyo, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In order to achieve the highest field performance for SSC magnets, superconducting wires with small filaments have been required. Superconductors wires with filament size of 1~3 microns having excellent critical current densities have been already developed. For instance, a NbTi alloy superconducting wire with a filament size of about five micron achieved Jc~2.8 x 105 A/cm2 at 5T and 4.2K. A Nb3Sn compound superconducting wire with a filament size of about one micron also performed Jc~2.3 x 105 A/cm2 at 8T and 4.2K. This paper attempts to clarify and propose standard Nb-50 wt% Ti alloy and multifilamentary bronze Nb3Sn configurations of interest to SSC magnet designers.

7127 (DOE/ER/40238—1, pp 3717-3718) **Magnet correction by figure eights.** Purcell, J.; Chen, W.; Peuron, A. (GA Technologies Inc., San Diego, CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

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Figure eights - superconducting loops with a figure eight geometry - provide an automatic, passive method for improving the field uniformity of superconducting dipole magnets. Figure eights are especially well suited for correcting iron-dominated dipoles operating at three tesla, where saturation of the iron makes it difficult to maintain acceptable field uniformity over the full operating range. By using figure eights to provide the final increment of field uniformity, the specifications and cost of the dipoles can be reduced. The figure eights themselves have very modest superconducting technology requirements and can be manufactured by mass production methods at very low cost.

7128 (DOE/ER/40238—1, pp 3719-3721) **Construction and test results of a 10 dipole magnet.** Shintomi, T.; Wake, M.; Tsuchiya, K.; Kobayashi, M.; Mito, T.; Hirabayashi, H.; Aihara, K.; Asano, K.; Hakuraku, Y.; Suzuki, F.; Suzuki, T. (KEK National Lab. for High Energy Physics, Ibaraki-ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 10T superconducting NbTi/Cu window frame dipole magnet, cooled in a horizontal pressurized helium II bath, was constructed and successfully tested. The dipole magnet coil and clamping structure, trained three times at 4.2K, was cooled down to 1.8K. In the first excitation at this temperature, the central dipole field induction reached to 9.3T, corresponding a maximum field in the coil of 10.4T. This is a record maximum field in this kind of dipole magnets.

7129 (DOE/ER/40238—1, pp 3722-3724) **Numerical solution of boundary condition to POISSON's equation and its incorporation into the program POISSON.** Caspi, S.; Helm, M.; Laslett, L.J. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Two dimensional cartesian and axially-symmetric problems in electrostatics or magnetostatics frequently are solved numerically by means of relaxation techniques - employing, for example, the program POISSON. In many such problems the sources (charges or currents, and regions of permeable material) lie exclusively within a finite closed boundary curve and the relaxation process in principle then could be confined to the region interior to such a boundary - provided a suitable boundary condition is imposed onto the solution at the boundary. This paper discusses and illustrates the use of a boundary condition of such a nature in order thereby to avoid the inaccuracies and more extensive meshes present when alternatively a simple Dirichlet or Neumann boundary condition is specified on a somewhat more remote outer boundary.

7130 (DOE/ER/40238—1, pp 3725-3727) **Effect of manufacturing errors on field quality of dipole magnets for the SSC.** Meuser, R.B. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

For superconducting dipole magnets of the sort proposed for the Superconducting Super Collider, the effects of various random manufacturing errors upon random magnet-to-magnet magnetic-field aberrations are analyzed. The errors considered are ones that are directly related to manufacturing tolerances and measurable dimensions of parts and materials. These errors affect the position of the boundaries of each layer of conductors in each quadrant and the positions of conductors within those boundaries. Manufacturing errors were estimated for the Fermilab Tevatron magnets and the BNL CBA magnets. The estimates were then adjusted so that the calculated field aberrations matched the measured values. Those errors were then applied to the SSC magnet reference designs currently under study in order to obtain estimated field aberrations.

7131 (DOE/ER/40238—1, pp 3728-3730) **Design and performance of 40 mm, 6.5 T, collared, cold-iron model magnets.** Peters, C.; Gilbert, W.; Hassenzahl, W.; Mirk, K.; Rechen, J.; Scanlan, R.; Taylor, C. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Model magnets have been built and tested at the Lawrence Berkeley Laboratory to verify a candidate design for the main bending magnets of the SSC. Construction of this series of dipole models was begun in October 1984 and will be completed in October 1985. To date, three models with collars, C1, C2, and C3, have been completed. Model C1 and C2 have been tested.

7132 (DOE/ER/40238—1, pp 3731-3733) **Sextupole correction coils for SSC model dipoles.** Rechen, J.B.; Gilbert, W.S.; Hassenzahl, W.V. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Local correction of the sextupole error field is proposed for the dipoles of the SSC. This requirement is imposed on the design by the high field quality required both during injection at low fields and during colliding beam operation at high fields. Error fields in the main dipole windings due to superconductor magnetization and conductor misplacements add unwanted sextupole and decapole magnetic field terms. To correct the sextupole error field the authors have constructed sextupole coils made of a single layer of superconducting wire and have mounted them with high precision on the stainless steel bore tube. These correction coils have been operated with 1 meter long SSC model dipoles in both the self-powered and externally-powered modes. The sextupole field in the bore has been reduced by as much as a factor of 50. The level of correction depends strongly on the angular alignment of the correction coil with respect to the sextupole error field it is to correct. Results of tests, performance of the correction coils and alignment requirements for the system are presented.

7133 (DOE/ER/40238—1, pp 3734-3736) **Characteristics and performance of the system developed for magnetic mapping of the NSCL superconducting K800 cyclotron magnet.** Harwood, L.H.; Nolen, J.A. Jr.; Fowler, M.; Fox, R.; Hanawa, H.; Zeller, A.F. (National Superconducting Cyclotron Lab., East Lansing). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The median plane magnetic field of the NSCL superconducting cyclotron magnet (max. field $\approx$ 6T) has been mapped using an NMR with a $D_2O$ probe to measure the field at the center and a search-coil/voltage-to-frequency convertor combination to measure the difference in field between the center and any other point of the magnet. With radial intervals of 2.54 mm and angular intervals of $\sim 1^\circ$, 360° maps took about 40 min. Radial calibrations were done with a laser interferometer and angular positions were measured with an encoder with 0.001° resolution.

7134 (DOE/ER/40238—1, pp 3737-3739) **New technique for wiring SSC superconducting sextupole corrector coils.** Leon, B. (Multiwire Div./Kollmorgen Corp., Hicksville, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

There exists in the electronics industry, a technology for the manufacture of printed circuit (PC) boards which is directly transferable into the creation of highly controlled coils, such as the SSC sextupole superconducting corrector coils. This technology, which uses a process of laying down insulated wire in highly controlled patterns has heretofore been confined exclusively to the manufacture of high density printed circuit (PC) boards, possibly due to an ignorance of its utility in the field of precision winding of coils. This ability to fix wires in a well defined location can be used to produce precision wound coils in a very cost-effective manner. These coils may be superior in quality to conventionally made coils. Before describing what can be created with this technology, it is necessary to take a look at this coil winding process, the MULTIWIRE process, and the industry which has utilized this technology.

7135 (DOE/ER/40238—1, pp 3743-3745) **Limitation of critical current density by intermetallic formation in fine filament Nb-Ti superconductors.** Larbalestier, D.C.; Chengren, L.; Starch, W.; Lee, P.J. (Univ. of Wisconsin, Madison). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Two experiments have been performed to investigate the role that the intermetallic reaction between the copper matrix and the Nb-Ti filaments plays in limiting the critical current density (J/sub c/) of Nb 45.6 wt% Ti composites. The first experiment involved composites which were industrially extruded. It was found that as the number of heat treatments increased, the J/sub c/ declined, the resistive transition broadened and the filaments sausaged. The filament sausaging was initiated by intermetallic particles at the filament matrix interface. A series of many heat treatment procedures were then applied to composites fabricated in the authors own laboratories without extrusion. Very high J/sub c/ values were obtained at filament sizes of 20 μm. When the same heat treatment procedures were applied to 4 - 5 μm conductors, extensive sausaging and degraded J/sub c/ values resulted. This degradation was also found to be due to the formation of Cu-Nb-Ti intermetallic compounds. It is concluded that a reliable filament diffusion barrier technology is necessary to permit full flexibility in the heat treatment of 2 - 5 μ filament Nb-Ti composites.

7136 (DOE/ER/40238—1, pp 3746-3748) **28 kV +/- 0.020% 200 kW dc power supply.** McGhee, D.; Praeg, W.; Bogaty, J. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Design, construction and testing of a prototype HV power supply for the klystrons of the 300 MeV racetrack microtron (MUSL) of the University of Illinois are described. Regulation of 0.02% is achieved with three voltage feedback loops. Two loops to thyristor phase control circuits on the ac primary of a 12-phase rectifier transformer regulate its output to within +/- 0.2% (line regulator). A third loop controls a series-connected tetrode to bring the output to within +/- 0.02% of the present value. The voltage drop across the tetrode can be set between 800 V and 1600 V; this setting is maintained by one of the loops to the line regulators. Other unique features are protective circuits that limit the fault current to 150% of the rated current when the klystron and/or the tetrode spark over. Voltage spikes generated by the thyristors are attenuated with LP-filters.

7137 (DOE/ER/40238—1, pp 3749-3751) **Multi-function ring magnet power supply for rapid-cycling synchrotrons.** Praeg, W.F. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Ring magnet power supply (RMPS) circuits that produce a wide range of magnet current waveshapes for rapid-cycling synchrotrons (RCS) are described. The shapes range from long flat-tops separated by a biased dual frequency cosine wave to those having a flat-bottom (injection), followed by a lower frequency cosine half wave (acceleration), a flat-top (extraction), and a higher frequency cosine half wave (magnet reset). Applications of these circuits for proposed synchrotrons are outlined. Solid-state switching circuits and the results of proof-of-concept tests are shown.

7138 (DOE/ER/40238—1, pp 3752-3754) **Magnet excitation circuits for DESY II.** Bothe, W.; Pillat, P. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In contrast to the existing synchrotron, DESY II will, since it is a separated function machine, have 5 independent magnet circuits: 1 for dipoles, 2 for quadrupoles and 2 for sextupoles. Moreover the repetition frequency will be 12.5 Hz instead of 50 Hz. The present White circuit allows the resonance frequency to be changed by a factor of 4 and will be used for the dipoles. The other 4 resonant circuits will be built from new elements and the magnet impedances are chosen such that all the magnets of one circuit can be connected in series. The dipole circuit will be operated with the existing dc-power supply and a new ac-power source of 12 pulse cycloconverter type without circulating current will be installed. The quadrupole and sextupole circuits will be excited by combined ac- and dc-power supplies of the type used for the FNL booster synchrotron.

7139 (DOE/ER/40238—1, pp 3755-3756) **Pulsed power supplies for the Fermilab 1 TeV switchyard.** Bartelson, L.; Walton, J. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

An upgraded system of pulsed switching magnets has been implemented in the Fermilab Switchyard to accommodate proton energies up to 1 TeV. These devices are required for switching the slow and fast extracted beams into their respective beam lines. Slow beam passes undeflected through the magnet in the off condition. During a pulse slow is disabled and fast, which is of ~1 ms duration, is deflected. The requirement then is for a flat-top current pulse of minimum rise and fall time. The circuit chosen is of the resonant charge recovery type. Several different styles and combinations of magnets are employed according to beam line requirements and constraints. In all cases maximum voltage is limited to 600 volts and pulse width to 100 ms.

7140 (DOE/ER/40238—1, pp 3757-3759) **Magnet current bypass shunt.** Cilyo, F.; McCarthy, J.; Wisner, B. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A precision active shunt has been developed for fine tuning of individual magnet fields in a series magnet string operated from a single power supply. The shunt uses power transistors operated in linear mode to regulate the bypass current in the range 0 to 50 A with precision of +/- 10 mA. Communication with and control of shunt which may be floating 1000 V or more above earth ground, is by means of transformer coupled isolation amplifiers. Because of reliability requirements, 7 transistors, mounted on demountable water cooled copper plate are used. Low level electronics and current sensing resistor are mounted on the same plate. This paper presents system description and preliminary results.

7141 (DOE/ER/40238—1, pp 3760-3762) **Precision pulser for main ring extraction.** Dinkel, J.; Biggs, J. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A pulser has been designed to produce a 14 Hz sinusoid current pulse at a 2 s rate with peak amplitudes from 400 amps to 3750 amps, and a long term stability of +/-400 mA. Short term stability is achieved by the use of a precision voltage regulator for the capacitor bank. This voltage regulator uses gate turnoff thyristors to control the charging current to the 13 mF capacitor bank. Load current is monitored with a precision dc current transductor. The peak value is read into a single chip microcomputer programmed to act as a digital regulator. The microcomputer calculates reference values for the capacitor bank charging supply and the capacitor bank voltage regulator.

7142 (DOE/ER/40238—1, pp 3763-3765) **Fermilab D0 overpass power supply system.** Merz, W.; Pfeffer, H. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The overpass power supply system consists of two power supplies. A 1 kV, 3600A SCR supply drives eight Main Ring type magnets and must track twice the Main Ring current to within +/- 0.1%. The second supply drives trim coils wound inside four of the main magnets. This dual-converter SCR supply, a modified Fermilab H.O.P.S. unit, supplies +/- 50A at +/-30V and it must generate +/-200V swings to buck-out the voltage inductively coupled from the main supply. Both power supply regulators use dead reckoned voltage drive programs to extend their effective bandwidths.

7143 (DOE/ER/40238—1, pp 3766-3768) **Tevatron extraction pulser.** Pfeffer, H. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The Tevatron QXR (Quadrupole Extraction Regulator) power supply is a linear current pulser combined with a dc transistor regulator. The pulser produces programmable current pulses of up to 250 amps with a maximum duration of 12 ms and a maximum voltage drive of +200/-250 volts. Its fastest repetition rate is 1 Hz. Between pulses a single power transistor regulator maintains 0 to 50 amps in the quadrupole magnet load. The pulser is an air-cooled 34 FET transistor bank operating in the linear region.

7144 (DOE/ER/40238—1, pp 3775-3777) **Application of GTO thyristor to a dual resonant frequency circuit for the magnet of a rapid-cycling synchrotron.** Someya, H.; Adachi, T.; Baba, H.; Irie, Y.; Matsumoto, S.; Sasaki, H.; Yano, Y. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The first application of a gate-turn-off thyristor to a dual resonant frequency circuit for exciting a rapid-cycling synchrotron magnet has been proposed. For the achievement of this proposal, a small-size model circuit has been constructed and tested. This article describes the experimental results, and some remarks are pointed out.

7145 (DOE/ER/40238—1, pp 3778-3780) **Very high precision current regulated power supplies for the Fermilab antiproton source.** McCarthy, J.; Wolff, D.; Farkas, L. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

These power supplies were designed to power the accumulator and debuncher storage rings at the Fermi National Accelerator Laboratory Antiproton Source. The accumulator and debuncher are both large acceptance 8 GeV storage rings. The accumulator ring has the most stringent requirements since it will be required to store beams for periods in excess of 24 hours. In order to ensure long term beam stability, resonances up to order 11 must be avoided. Because of this stringent tuned stability requirement, the power supplies which power the three main quadrupole and the main dipole busses must be extremely stable. Thus the current regulation specification for these power supplies is 10 PPM (0.001%) including differential and common mode ripple, long term drift, and line and load regulation.

7146 (DOE/ER/40238—1, pp 3781-3783) **Bilateral power supply with energy storage buffer for the superconductive coils of large particle accelerators.** Ehsani, M.; Kustom, R.L. (Texas A & M Univ., College Station). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Considerable development and testing on the active control of current in superconducting coils using DC-AC-DC thyristor convertor networks with suerpconductive magnetic energy storage has been completed. The charging and discharging cycles of the magnet are decoupled from the power grid, and since these networks are asynchronous with the line, operation at any practical frequency for the switching devices is possible. These systems, avoid putting large power bumps on the utility grid during charging and discharging, eliminate phase related noise on other 60 Hz converter systems, and reduce the size of magnet ripple. Operation and design of thyristor networks in closed-loop feedback with variable phase and frequency modes are discussed. Techniques for switching operation at one phase and frequency to another are described. Operating data on a bang-bang controller for 100 A., 4 Hy. load and storage coils is given.

7147 (DOE/ER/40238—1, pp 3784-3786) **Evaluation of the GTO for 270 mva interrupter applications.** Ehsani, M.; Kernaghan, W.H. (Texas A & M Univ., College Station). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The fundamental problem of interrupting a direct current is producing a current zero which will allow for the elimination of current flow. Historically, external circuits have been used to extinguish a plasma (arc) conducting medium by counterpulsing the arc current to zero. Preliminary results show that solid-state dc interrupters utilizing gate turnoff thyristors can provide for reduced capacitive energy storage requirements over vacuum interrupters and SCRs in creating a current zero. Additionally, the hardware required in the gate circuit of the GTO is significantly reduced over the counterpulse circuits in vacuum interrupters and SCRs by taking advantage of the turn-off gain available in the GTO. Interrupters designed around the GTO can have applications in the power conditioning and protection circuits of particle accelerators and fusion reactors.

7148 (DOE/ER/40238—1, pp 3790-3791) **Long removable cryogenic transfer lines.** Mallory, M.L.; Laumer, H.W.; Gavalya, A. (Michigan State Univ., East Lansing). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Easily removable cryogenic transfer lines of lengths up to 63 feet have been successfully constructed and operated at the National Superconducting Cyclotron Laboratory. For the initial testing phase of the K-800 superconducting magnet, temporary lines which span a rather long distance between coil cryostat and a helium refrigerator were built. Eventually, a low heat load cryogenic distribution system will be constructed. The differential contraction between the cold inner pipe and ambient temperature outside vacuum jacket presents design problems for stainless steel bayonet transfer lines. The traditional solution to the contraction problems, contraction loops or bellows, usually results in a fixed line. Using the alloy Invar 36, which has a contraction coefficient ~ 1/8 of stainless steel, simple bayonet type transfer lines have been built. A lifting fixture is used for line installation.

7149 (DOE/ER/40238—1, pp 3797-3799) **Ultrahigh vacuum system of the heavy ion transport line at Brookhaven.** Hseuh, H.C.; Feigenbaum, I.; Manni, M.; Stattel, P.; Skelton, R. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Heavy ions with an energy up to 8 MeV/A for $S^{+16}$ and 1 MeV/A for $Au^{+34}$ from the 16 MV Tandem will be injected into the AGS for further acceleration to ≦ 15 GeV/A. A 600-meter beam transport line between the Tandem and the AGS has been designed and is under construction. This paper describes the design of the vacuum system of this transport line and the performance of the prototype vacuum sectors.

7150 (DOE/ER/40238—1, pp 3800-3802) **High vacuum portable pumping station suitable for accelerating use.** Stattel, P.; Briggs, J.; DeBoer, W.; Skelton, R. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The need for a Portable Pump Station for Ultra High Vacuum use became apparent when the Isabelle collider was first being designed. A Portable Pump Station had to be developed which contained the following features: 1) Maneuverability; 2) Compact size; 3) Rugged; 4) Self protected against various failures; 5) capable of running unattended; 6) Capable of reaching $10^{-9}$ Torr. The Pump Station that was developed and other variations are the subject of this paper. Emphasis will be on the Isabelle and HITL versions.

7151 (DOE/ER/40238—1, pp 3803-3805) **Method for compensating bellows pressure loads while accommodating thermal deformations.** Woodle, M.H. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Many metal bellows are used on storage ring vacuum chambers. They allow the ring to accommodate deformations associated with alignment, mechanical assembly and thermal expansion. The NSLS has two such electron storage rings, the VUV ring and the X-Ray ring. Both rings utilize a number of welded metal bellows within the ring and at every beam port. There are provisions for 16 beam ports on the VUV and 28 ports of the X-Ray ring. At each of these locations the bellows are acted on by an external pressure of 1 atmosphere, which causes a 520 lb. reaction at the vacuum chamber beam port and at the beamline flange downstream of the bellows. The use of rigid tie rods across the bellows flanges to support the load is troublesome because most storage ring vacuum chambers are baked in situ to achieve high internal vacuum. Significant forces can develop on components if thermal deformation is restrained and damage could occur.

7152 (DOE/ER/40238—1, pp 3806-3808) **Radiation resistance of elastomers.** Lee, G. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Various data has indicated that some elastomers have much higher radiation resistance than Viton. Nine samples of elastomers were irradiated with gamma rays. Two Ethylene Propylene Diene compounds, EPDM's, were found to exhibit acceptable properties for o-rings after radiation levels of $5 \times 10^8$ rads, while Viton failed at $1 \times 10^7$ rads. Vacuum tests also were favorable so EPDM o-rings were chosen as seals in the Energy Saver cryostat vacuum system.

7153 (DOE/ER/40238—1, pp 3812-3814) **Beam line windows in LAMPF.** Brown, R.D.; Grisham, D.L.; Lambert, J.E. (Los Alamos National Lab., NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The A-6 main beam-line window at LAMPF separates the vacuum of the main beam line from the isotope production station, proton irradiation ports, and the beam stop, which operate in air. This window must withstand the design beam current of 1 mA at 800 MeV for periods of at least 3000 hours without failure. The window is water cooled and must be strong enough to withstand the 2.1 MPa (300 psig) cooling water pressure, as well as beam-induced thermal stresses. Two designs have been used to meet these goals, a stepped-plate window and a hemispherical window, both made from a precipitation-hardened nickel base alloy, Alloy 718. Calculations of the temperatures and stresses in each of these windows are presented.

7154 (DOE/ER/40238—1, pp 3815-3817) **Tailored vacuum chambers for AC magnets.** Harvey, A. (Los Alamos National Lab., NM). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The proposed LAMPF-II accelerator has a 60-Hz booster synchrotron and a 3-Hz main ring. To provide a vacuum enclosure inside the magnets with low eddy-current losses and minimal field distortion, yet capable of carrying RF image currents and providing beam stabilization, the authors propose an innovative combination pipe. Structurally, the enclosure is high-purity alumina ceramic, which is strong, radiation resistant, and has good vacuum properties. Applied to the chamber are thin, spaced, silver conductors using adapted thick-film technology. The conductor design can be tailored to the stabilization requirements, for example, longitudinal conductors for image currents, circumferential for transverse stabilization. The inside of the chamber has a thin, resistive coating to avoid charge build-up. The overall 60-Hz power loss is less than 100 W/m.

7155 (DOE/ER/40238—1, pp 3818-3820) **High vacuum chambers for high energy physics.** Matarrese, G.R. (Pro.Cu.Ra. Impianti S.R.L., Milano, Italy). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

This paper reports the design, manufacture, finishing, cleaning and testing systems used for production of stainless-steel welded high vacuum chamber pipes. The authors manufacture high vacuum chamber pipes for high energy accelerating machines and particularly for the S.P.S. Super Proton Synchrotron Accelerator Main Ring Vacuum System.

7156 **(LA-UR—86-3394) Los Alamos Neutron Scattering Center.** Silver, R.N. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-861231—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001953.

From Communication on the material science and engineering study conference; Boston, MA, USA (1 Dec 1986).

The Los Alamos Neutron Scattering Center (LANSCE) is a new pulsed spallation neutron source at the Los Alamos National Laboratory for neutron scattering research in the structure and dynamics of materials. LANSCE is expected to achieve the world's highest peak thermal neutron flux of $1.7 \times 10^{16}$ n/cm$^2$-sec at 12 Hz by 1988. The scientific potential and development plans for the facility are described.

7157 **(LA-UR—86-3636) White neutron source from 1 to 400 MeV.** Wender, S.A.; Lisowski, P.W. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 17p. (CONF-861114—18). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001978.

From 9. international conference on application of accelerators in research and industry; Denton, TX, USA (10 Nov 1986).

A new high intensity white neutron source has recently been constructed at Los Alamos. Beams of nuetrons with a continuous energy distribution up to several hundred MeV are produced by the spallation reaction using the 800 MeV pulsed proton beam from the Los Alamos Meson Physics Facility (LAMPF) linear accelerator. The neutron facility has been designed to make very efficient use of the LAMPF beam with several experiments being able to operate simultaneously. Typical running conditions involve approximately 50,000 bursts/sec and proton beam currents of 2.5 microamperes. Experiments planned for this fall include gamma-ray production, neutron induced fission, and medium energy (n,p) and (p,n) studies. 1 ref., 7 figs., 1 tab.

7158 **Polarized internal target apparatus.** Holt, R.J. (to Dept. of Energy, Washington, DC). US Patent 4,617,462. 14 Oct 1986. Filed date 10 Oct 1984. vp.

This patent describes a polarized internal target apparatus. The apparatus consists of structural means having diametrically opposite openings for the passage of a particle beam and otherwise defining a cell region, means for forming a mixture of target gas and alkali gas atoms at a ratio of the order of about 20-200:1 and introducing the mixture to the cell region. The apparatus also has a means for passing a high intensity polarized light source into the mixture to polarize the alkali atoms, the polarized alkali metal gas atoms in collisions with the target gas atoms causing polarization of the target gas atoms, and means for subjecting the target cell to a magnetic field of the order of 3-50 gauss. The target gas atoms are hydrogen or deuterium and the alkali atoms being sodium or potassium.

7159 **Undulator source beamline for soft X-ray imaging.** Rarback, H.; Krinsky, S.; Mortazavi, P.; Shu, D.; Kirz, J.; Jacobsen, C.; Howells, M. (Brookhaven National Lab., Upton, NY, USA. National Synchrotron Light Source; State Univ. of New York, Stony Brook, USA. Dept. of Physics; Lawrence Berkeley Lab., CA, USA. Center for X-ray Optics). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **246**: No. 1-3, 159-162(15 May 1986). (CONF-850734—). Contract AC02-76CH00016.

From 2. international synchrotron radiation instrumentation conference; Stanford, CA, USA (29 Jul 1985).

We are building an undulator and beamline at the NSLS to be used primarily for soft X-ray imaging of biological specimens. The source and beamline are designed to produce high coherent power with enough temporal coherence to allow the practical use of those imaging techniques which require this coherence. A description of the undulator and beamline is given.

7160 **First operation of an extended range grasshopper monochromator on the Aladdin storage ring.** Brown, F.C.; Stott, J.P.; Hulbert, S.L. (Illinois Univ., Urbana, USA. Dept. of Physics; Wisconsin Univ., Stoughton, USA. Synchrotron Radiation Center; Brookhaven National Lab., Upton, NY, USA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **246**: No. 1-3, 278-281(15 May 1986). (CONF-850734—).

From 2. international synchrotron radiation instrumentation conference; Stanford, CA, USA (29 Jul 1985).

First operation of a new extended range monochromator on the 1 GeV storage ring Aladdin is described. Curves are given of output flux as a function of photon energy for the 2 m and for the 5 m gratings as measured with an NBS diode. Relatively low background and flux up to 1500 eV is obtained using a 1200 line/mm 5 m holographic grating. Highly reproducible scans were obtained of the transmission of thin films including the carbon K and titanium L edges. This reproducibility and high throughput is in large part due to the small beam size and excellent stability of Aladdin.

7161 **Laser plasma LINAC.** Palmer, R.B.; Baggett, N.; Claus, J.; Fernow, R.; Ghosh, A.; Giordano, S.; Radeka, V.; Stumer, I.; Takacs, P.; Warren, J. (Brookhaven National Lab., Upton, NY). *Proceedings of the International Conference on Lasers;* 472-477(26 Nov 1984).

From Proceedings of the international conference on lasers; San Francisco, CA, USA (26-30 Nov 1984).

The grating accelerator concept is reviewed. The use of a double row of conducting droplets instead of a conventional grating constrains the fields to a narrow band. The use of droplets also allows fields that will destroy the structure. Rf modeling results are presented together with a simple theory of the fields. Coupling to incoming radiation is described. A possible laser specification is also given. 9 references, 8 figures, 1 table.

7162 **A flexible automated waveform recorder data acquisition program.** Boyer, W.B. (Pulsed Power Engineering Div. 1251, Sandia National Labs., Albuquerque, NM). pp 69-70 of Proceedings of the 1984 IEEE instrumentation and measurement conference. Piscataway, NJ; IEEE Service Center (1984). (CONF-840115—). Contract AC04-76DP00789.

From Instrumentation and measurement technology conference; Long Beach, CA, USA (17 Jan 1984).

Software has been developed to record signals in automated data acquisition systems that support pulsed power accelerators at Sandia. The software achieves flexibility by being entirely table driven. Before each accelerator shot the program processes input files, sets up and checks out all programmable hardware. After the shot the program automatically reads each signal, calibrates it and stores it in a disc file. The software is currently running in 3 different facilities with up to 60 waveform recorder channels.

## 4304 Storage Rings

*REFER ALSO TO CITATION(S) 7072, 7076, 7111, 7160*

7163 **(CONF-860789—1) Structure of a one-component plasma in an external field: a molecular dynamics study of particle arrangement in a heavy-ion storage ring.** Rahman, A.; Schiffer, J.P. (Minnesota Univ., Minneapolis (USA); Argonne National Lab., IL (USA); Chicago Univ., IL (USA)). Jul 1986. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001537.

From International workshop on condensed matter theories; Argonne, IL, USA (21 Jul 1986).

A one-component plasma has been studied by molecular dynamics calculations to simulate the behavior of charged particles in heavy-ion storage rings. The Hamiltonian used confines the plasma in the direction of travel in the ring in the frame of reference which is moving with the beam. The results show an unexpected stratification of density in the lateral direction, and a tendency towards a first-neighbor coordination of 14(8 + 6) seems incipient. On each shell we observe a triangular pattern of particle arrangement.

7164 (DOE/ER/40238—1, pp 3252-3255) **RFQ-injector for HERA.** Schempp, A.; Klein, H.; Schastok, P. (Universitaet Frankfurt am Main, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

For the HERA project at DESY an RFQ will be built as injector for a 20 mA $H^-$ beam from 18 to 750 keV with a duty cycle of $10^{-4}$. The low average power and the moderate electrode voltage of 70 kV allows a flexible and simple design of the resonator. The design of the RFQ is described and the status of the project is discussed.

7165 (DOE/ER/40238—1, pp 3386-3388) **20-keV undulators for a 6-GeV storage ring.** Kim, S.H.; Cho, Y. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The main goal of the future 6-GeV electron storage ring is to provide 20-keV fundamental harmonic radiations from insertion devices. Parameter restrictions of REC-vanadium permendur hybrid undulators have been examined. The critical factor is the achievable minimum gap of the undulator. Variations of the spectral brilliance for different beam parameters are also shown.

7166 (DOE/ER/40238—1, pp 3389-3390) **Synchrotron radiation vacuum chamber installation and beam size.** Shleifer, M. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In this paper the authors address the question of storage ring vacuum chamber placement and its effect on the synchrotron radiation fan obtainable. They consider only horizontal errors and thus treat the problem two-dimensionally. Specifically, they describe the correlation between the parameters of the chamber of and its position in the magnet and the size of the fan of radiation emerging from a port.

7167 (DOE/ER/40238—1, pp 3391-3393) **Study for a 6 GeV undulator based synchrotron radiation source.** Vignola, G.; Barton, M.; Blumberg, R.; Galayda, J.; Krinsky, S.; Luccio, A.; Pellegrini, C.; van Steenbergen, A.; Wang, J. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A partial study for a 6 GeV undulator based synchrontron radiation source for production of high brightness undulator radiation, in the A region, is presented. The basic lattice adopted for the storage ring is a hybrid FODO Chasman-Green lattice, making use of gradient in the dipoles. The authors discuss also the e beam current limits and the injection parameters.

7168 (DOE/ER/40238—1, pp 3394-3396) **Studies of positional stability of the electron beam in the NSLS storage ring.** Yu, L.H.; Nawrocky, R.J.; Galayda, J. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Positional stability of the electron beam is critically important to experimental beam line users. The beam position vibration increases the effective beam size and thus reduces the brightness. So the potential stability measurement provides important information for beam lines. Data about amplitude and frequency of beam vibration and long term beam movement at different beam ports can be useful in locating the noise source for accelerator physicists. For the noise which cannot be eliminated, a beam position monitor can provide the signal for the feedback system to stabilize the beam position. These consideration become more evident as higher brightness and better energy resolution are sought. In this paper the authors report a preliminary result of the beam position stability measurement at the NSLS.

7169 (DOE/ER/40238—1, pp 3400-3402) **European Synchrotron Radiation Facility.** Tazzari, S. (European Synchrotron Radiation Project, Geneva, Switzerland). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A new design study for the European Synchrotron Radiation Facility (ESRF) has been carried out in the past year by the European Synchrotron Radiation Project Group. The aim was to extend the work done in 1979 and 1982, under the auspices of the European Science Foundation, towards a very high brilliance, hard X-ray machine. The guidelines for the design of a dedicated Synchrotron Radiation Source in the X-ray region were laid out in 1982 by the ESRF study group and confirmed at a ESRP workshop in 1983. It was concluded then that a low emittance storage ring with a large number of straight sections for wiggles and undulators, and the capability sections for wigglers and undulators, and the capability for also providing bending magnet sources in the 1 A wavelength region should be built. The possibility of deciding on the number of a given type of device at a late stage in the project, or indeed at any time during operation, was deemed to be an important design feature.

7170 (DOE/ER/40238—1, pp 3403-3405) **Electron undulating ring for VLSI lithography.** Tomimasu, T.; Noguchi, T.; Sugiyama, S.; Yamazaki, T.; Mikado, T. (Electrotechnical Lab., Ibaraki, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The development of the ETL storage ring TERAS as an undulating ring has been continued to achieve a wide area exposure of synchrotron radiation (SR) in VLSI lithography. Stable vertical and horizontal undulating motions of stored beams are demonstrated around a horizontal design orbit of TERAS, using two small steering magnets of which one is used for vertical undulating and another for horizontal one. Each steering magnet is inserted into one of the periodic configuration of guide field elements. As one of useful applications of undulating electron beams, a vertically wide exposure of SR has been demonstrated in the SR lithography. The maximum vertical deviation from the design orbit occurs near the steering magnet. The maximum vertical tilt angle of the undulating beam near the nodes is about +/- 2mrad for a steering magnetic field of 50 gauss. Another proposal is for high-intensity, uniform and wide exposure of SR from a wiggler installed in TERAS, using vertical and horizontal undulating motions of stored beams. A 1.4 m long permanent magnet wiggler has been installed for this purpose in this April.

7171 (DOE/ER/40238—1, pp 3406-3408) **Generation of quasi-monochromatic photon beams from Compton backscattered laser light at ETL electron storage ring.** Yamazaki, T.; Noguchi, T.; Sugiyama, S.; Mikado, T.; Chiwaki, M.; Tomimasu, T. (Electrotechnical Lab., Ibaraki, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Generation of quasi-monochromatic photon beams of energy variable between 1.7 - 6.5 MeV has been observed by inducing the Compton backscattering of laser light quanta on electrons of energy 305 - 606 MeV at the injection straight section of the 600-MeV ETL storage ring. A Nd-YAG laser of wavelength 1.0641μm has been used with output power 0.7 - 1.2 W. The resultant photon spectra are measured with a pure Ge detector, some of which are presented in the present report together with some description on the experimental methods. The absolute yields are being measured by the use of an 8 inch phi x 8 inch long NaI scintillation counter.

7172 (DOE/ER/40238—1, pp 3409-3411) **Present status of UVSOR.** Kasuga, T.; Yonehara, H.; Kinoshita, T.; Hasumoto, M. (Institute for Molecular Science, Aichi-Ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

UVSOR constructed at the Institute for Molecular Science is an electron storage ring dedicated to synchrotron radiation research in molecular science and its related fields. The construction started in 1981, and the first beam was stored on 10th of Nov. in 1983. The maximum beam current up to this time is 200 mA and the e-folding lifetime of the beam is about 2 hours at the beam current of 100 mA. The injection energy of the ring is 600 MeV, and the injected beam can be accelerated up to 750 MeV. The critical wavelength of the synchrotron radiation from the ordinary bending magnets is 56.9 A at the electron energy of 600 MeV. A superconducting wiggler of which magnetic field is 4T is installed in 1984. This field strength gives the critical wavelength of 16.2 A at 600 MeV. An undulator with permanent magnets was also constructed. Single bunch operation was tried successfully. Some experimental works using synchrotron radiation have just started in 1984.

7173 (DOE/ER/40238—1, pp 3412-3414) **Undulator and wiggler of UVSOR.** Yonehara, H.; Kasuga, T.; Matsudo, O.; Kinoshita, T.; Hasumoto, M.; Yamazaki, J.; Kato, T.; Yamakawa, T. (Institute for Molecular Science, Aichi-ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 600 MeV electron storage ring whose nickname is UVSOR (Ultra Violet Synchrotron Orbital Radiation) was constructed at Institute for Molecular Science to be a synchrotron radiation source for the research of molecular science and its related fields. New light sources, a permanent magnet undulator and a wiggler were installed in the ring. The undulator has 35 periods and its maximum magnetic field is 0.3 T. The maximum magnetic field of the wiggler is 4 T. Electron beam could be injected and stored in the ring when these devices were excited with the maximum magnetic fields, individually. Results of the measurement of the magnetic field distributions of them, and tune shifts and closed orbit distortions due to them are presented.

7174 (DOE/ER/40238—1, pp 3415-3417) **Gamma ray source using targets in the TRISTAN accumulation ring.** Oide, K.; Fukuma, H.; Kamada, S.; Kikuchi, M.; Momose, T.; Satoh, K.; Shintake, T.; Tejima, M. (KEK, National Lab. for High Energy Physics, Ibaraki, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A gamma ray source using internal targets in an electron storage ring, TRISTAN Accumulation Ring (AR), has been operated since May 1984. As an alternative electron source TRISTAN AR is now operational, and is able to accelerate and store an electron beam of more than 5 GeV. The authors planned to extract high energy gamma rays by inserting an internal target into the AR, because a direct beam extraction is not easy. Two gamma ray lines are prepared by the two detector groups. Each detector group has its own target and gamma ray line. It is also required that the gamma rays should be simultaneously produced at the two targets with the least interference between them. The circulating electron beams gradually collide with the target and produce gamma rays, which are extracted from the AR through a Be-foil window. By a converter the gamma ray is changed into high energy electrons and positrons, which are finally used for the calibration of the lead glass counter. The momentum of the electron beam is defined by an analyzer magnet.

7175 (DOE/ER/40238—1, pp 3418-3420) **Lattice and bypass design for a coherent XUV facility.** Jackson, A.; Garren, A.A.; Vignola, G. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The design of a magnet lattice and bypass for a coherent radiation facility is discussed. The lattice is the missing magnet FODO structure first proposed by Vignola [3] for a 6 GeV light source. This has been adapted for a 750-1300 MeV electron storage ring for use with both conventional insertion devices and a high gain FEL optimized for output at 400 A. The latter device requires that the electron bunch be deflected into a small aperture bypass, then reinjected into the ring where the perturbing effects of the FEL are damped out.

7176 (DOE/ER/40238—1, pp 3421-3423) **Storage ring parameters for high gain FEL.** Kim, K.J.; Peterson, J.M. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2). Contract AC03-76SF00098.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors use one-dimensional free electron laser (FEL) theory to find criteria for choosing electron beam and undulator parameters for operation of a high gain FEL at 400 A. The criteria are (i) moderate electron beam energy (<1 GeV), (ii) high peak current (several hundred amperes), (iii) small emittance ($\sim 10^{-9}$ m-rad), (iv) small relative momentum spread ($\sim$0.001), and (v) narrow undulator gap ($\sim$3 mm). Results of two-dimensional simulations on FEL performance are also presented.

7177 (DOE/ER/40238—1, pp 3433-3434) **Low emittance configuration for spear.** Blumberg, L.N.; Harris, J.; Stege, R.; Cerino, J.; Hettel, R.; Hofmann, A.; Liu, R.Z.; Wiedemann, H.; Winick, H. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The quality of synchrotron radiation beams from SPEAR, in particular the brilliance of undulator radiation, can be improved significantly by reducing the emittance of the stored electron beam. A reduction of the horizontal emittance by a factor of 3.5 to a value of 130 nanometer-radians (nm-r) at 3 GeV has been achieved by using stronger focussing, mainly in the horizontal plane. The low emittance configuration also reduces the dispersion and vertical beta functions in the straight sections, making them more suitable for wigglers. The higher betatron tunes lead to a larger phase advance between the two kickers, which has to be corrected during injection by shunting current from some quadrupoles. The configuration was optimized within SPEAR hardware limitations and tested for dynamic aperture with the tracking program PATRICIA. After implementation of this scheme, beam was successfully injected and accumulated. The measured emittance of the stored beam was in agreement with calculations. Presently the configuration is being made operational.

7178 (DOE/ER/40238—1, pp 3436-3441) **Second collider in the CERN LEP tunnel for pp (p anti p) and ep physics in the multiTeV energy range.** 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The LEP collider at present under construction at CERN will provide $e^+e^-$ collisions in four large detectors, initially at a center of mass energy of 110 GeV to be gradually increased to $\sim$ 200 GeV by means of superconducting RF cavities. First beam is planned for the end of 1988. The tunnel has a circumference of $\sim$ 27 km and can house a second collider on top of the present one, designated as Large Hadron Collider (LHC). The LHC can be constructed with either one or two magnetic channels. The former allows collisions of protons with antiprotons circulating in the new channel in up to eight points, while protons can be made to collide with the electrons of LEP in the odd collision points, which are free from RF cavities. An LHC with two channels can of course provide pp collisions of high luminosity and the same ep possibilities as already indicated by using only one of the proton beams. Concerning hadronic collisions, the two-channel machine should produce a larger luminosity and be more reliable (ease of refill with protons, which are abundant) than the single channel one (p anti p) but will be more expensive due to the double magnets.

7179 (DOE/ER/40238—1, pp 3442-3446) **Accelerator physics studies for the SSC.** Chao, A.W. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In the spring of 1984, a reference designs study (RDS) was carried out to identify the issues and to provide a crude cost estimate of the SSC. Following the RDS, a Central Design Group was formed in October to perform the detailed design R & D for construction of the SSC. This paper is a brief review of progress made on the accelerator physics studies since October 1984. For major issues not discussed here, many of them of great importance, the RDS report is still the valid source of information.

7180 (DOE/ER/40238—1, pp 3447-3450) **Accelerator systems of the SSC.** Limon, P. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The Accelerator Systems Division (ASD) of the SSC is primarily concerned with the technical components of the main collider rings. The division is not directly responsible for the superconducting magnets, but the detailed design of the magnet package is strongly influenced by the designs of the other technical systems. In this paper, the authors outline the objectives and tasks of the ASD during the R & D phase of the SSC project, present the proposed organization of the division, and discuss the R & D work that is presently taking place.

7181 (DOE/ER/40238—1, pp 3451-3455) **Civil systems aspects of the SSC.** Sanford, J.R. (Lawrence Berkeley Lab., CA). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

This paper will briefly review the civil systems that were developed during the course of the RDS. The technical features of

the SSC led to a consideration of the siting needs and criteria. The criteria that have been suggested to DOE will be briefly described. Finally, the study and design work to be undertaken in the next couple years is outlined including a brief exploration of issues and problems.

7182 (DOE/ER/40238—1, pp 3456-3461) **Ironless cos Theta magnet option for the SSC.** Fisk, H.E.; Brown, B.C.; Carson, J.A.; Edwards, D.A.; Edwards, H.T.; Engler, N.H.; Gonczy, J.D.; Hanft, R.W.; Koepke, K.P.; Kuchnir, M.; Lundy, R.A. (Fermi National Accelerator Lab., Batavia, IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The Fermilab design of a 5 T, 5 cm aperture superconducting dipole is described, that attempts to integrate essential cryogenic details with a low cold mass, low heat leak magnet containing a coil surrounded by aluminum collars. Operating characteristics of coils made with aluminum collars are presented along with harmonic data obtained from 1 meter long 5 cm aperture collared coils. A summary of results obtained from cold tests of a 7.6 cm aperture, 6 m long aluminum collared coil in an iron vacuum vessel cryostat are reviewed. Results from the measurement of heat leak to 4.5K, 10K, and 80K are discussed for a 12 m prototype cryostat. Calculations are summarized for passively correcting the persistent current sextupole fields.

7183 (DOE/ER/40238—1, pp 3462-3465) **Superferric magnet option for the SSC.** Huson, F.R.; Bingham, H.; Colvin, J.; Davidson, M.; Greenough, J.; Heifets, S.; Hinterberger, H.; Kobayashi, M.; Lau, K.; Lopez, G.; McIntyre, P. (Texas Accelerator Center, Woodlands). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The basic design for the SSC started at Snowmass in the summer of 1982. The premise is that a superferric SSC has the potential to be simple, reliable, inexpensive and provide future flexibility. A concentrated effort began in March of 1984 when the Texas Accelerator Center was formed. The Texas Accelerator Center is a group of about 50 people divided into three areas of research, a calculations group working on beam dynamics, an R and D group working on superconducting magnets, and an R and D group working on new accelerator ideas including a proton linac and a plasma-laser accelerator. This paper will emphasize the work on the superferric magnet R and D.

7184 (DOE/ER/40238—1, pp 3466-3470) **Cold iron cos Theta magnet option for the SSC.** Reardon, P. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In this paper the authors review first the evolution over the past several years of a cold iron, high field cos Theta magnet design option for the SSC. The authors note the collaborative approach pursued by BNL and LBL on the 2-in-1 option, and the culmination of this effort in the tests of the BNL 4.5 m model magnets. Next, they discuss the subsequent 1-in-1 option being pursued jointly by BNL, Fermilab and LBL.

7185 (DOE/ER/40238—1, pp 3570-3573) **High gradient superconducting cavities for storage rings.** Sundelin, R.M. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Superconducting (SC) cavities for use in electron storage rings have advanced to the point where several laboratories are making definitive plans to use them on a large scale. Laboratory tests of multi-cell SC cavities, including input and higher-order-mode (HOM) couplers, have yielded accelerating fields up to 15.3 MeV/m (CW). Reasons for the improved performance are discussed. Since the 1983 International Accelerator Conference in August, 1983, four SC cavities have been tested in storage rings. The cavities have yielded accelerating gradients up to 6.5 MeV/m, in excess of the frequently-quoted objective of 5 MeV/m, in addition, the average gradient obtained in these four tests was 4 MeV/m, almost twice the average obtained in the four cavities tested in storage rings during 1982-1983.

7186 (DOE/ER/40238—1, pp 3578-3580) **Field quality and stability of permanent magnet quadrupoles.** Herb, S. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The authors plan to increase the peak luminosity of the Cornell Electron Storage Ring by providing tighter vertical focussing at the interaction points. The final focussing devices will be large permanent magnet quadrupoles operating inside the 10-15 kG solendoidal field of the experimental detector. They present the results of tests demonstrating that quadrupoles with the required field quality and resistance to demagnetization can be built from commercially available Rare Earth Cobalt magnets.

7187 (DOE/ER/40238—1, pp 3587-3589) **Superconducting 352 MHz prototype cavity for LEP.** Arnolds-Mayer, G.; Bernard, P.; Bloess, D.; Cavallari, G.; Chiaveri, E.; Haebel, E.; Lengeler, H.; Stierlin, R.; Tueckmantel, J.; Weingarten, W.; Piel, H. (CERN, Geneva, Switzerland). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

It is proposed to upgrade the large electron-positron storage ring LEP to energies above the initial 55 GeV by superconducting accelerating cavities operated at 352 MHz. A new cavity geometry has been developed which will allow to locate the main and higher order mode couplers at the beam tubes of the cavities. Experimental results obtained with monocell cavities fabricated from niobium material of different thermal conductivity and with a 4-cell prototype cavity are discussed.

7188 (DOE/ER/40238—1, pp 3596-3598) **Beam test of a 9-cell superconducting cavity in the PETRA storage ring.** Dwersteg, B.; Ebeling, W.; Moeller, W.D.; Proch, D.; Renken, D.; Susta, J.; Vogel, H. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

A 1 GHz 9-cell superconducting cavity was installed and tested in the PETRA electron-positron storage ring. 2 mA were injected at 7 GeV and stored by a superconducting cavity with a maximum gradient of 2.5 MV/m. With the addition of normal-conducting 500 MHz cavities the superconducting cavity transferred 27.5 kW to a 8 mA beam current. The resonator is kept at LHe temperature since February 1985 to gain long-time experience on superconducting cavities in the storage ring environment. The maximum achievable field and the quality factor have not changed up to now.

7189 (DOE/ER/40238—1, pp 3619-3621) **Air core quadrupole system for fast tune control in CESR.** Dean, D.A.; Rubin, D.L. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The guide field magnets in CESR have a frequency response of 0.5 Hz. To allow fast control of betatron tunes the authors have installed a system of air core quadrupoles. They describe the air core quadrupoles and present results of tests of the system for tune control, hysteresis free beta function measurements, and tune feedback.

7190 (DOE/ER/40238—1, pp 3704-3706) **Technological aspects of the LEP low-beta insertions.** Taylor, T.M. (CERN, Geneva, Switzerland). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

In order to obtain the highest luminosity at LEP, it is necessary to use superconducting quadrupoles for the final vertical focusing of the beams. The low-beta structure is such that these quadrupoles must be virtually integrated into the experiments, imposing severe constraints on their design. In particular, at LEP these magnets must be iron-free, occupy minimum space in the transverse direction, and be supported together with other beam- and experiment-related equipment on mobile cantilever girders. The constraints are analyzed, and the proposed system is described.

7191 (DOE/ER/40238—1, pp 3740-3742) **Design of the dipole magnet for the C version of the superconductin_ supercollider 20 TeV twin-beam proton accelerator (SSC).** Pissanetzky, S.; Schmidt, W. (Texas Accelerator Center, Woodlands). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The C version of the SSC dipole is a superconducting superferric magnet with a 1 by 1.4 in. bore. Injection is at 0.15 T and storage at 3.0 Tesla. The length of the ring is 140 km, and it contains 1000 dipoles 140 m long each. Each dipole is an over-under double-C magnet built of steel laminations, flooded with liquid helium, and with 8 turns of superconducting wire and one elliptic beam tube per section. A total of 6 bores have been built so far. They all showed excellent quench stability, and the field uniformity was good and in reasonable agreement with predictions. A detailed analysis of construction errors for dipoles has also been performed. Effects on field harmonics from as many as 9 different sources of error have been taken into account, including mechanical errors and errors in magnetic properties and excitation current. Studies and measurements of errors due to persistent currents and remanant fields have also been conducted. The authors report the results of the measurements and the error analysis.

7192 (DOE/ER/40238—1, pp 3769-3771) **Power supply control programs for the TRISTAN AR.** Fukuma, H.; Kabe, A.; Kubo, T.; Koiso, H.; Endo, K. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The power supplies of the TRISTAN Accumulation Ring (AR) have been operated under the KEK Nodal system since November 1983. This report describes the details of control programs and some discussions.

7193 (DOE/ER/40238—1, pp 3772-3774) **Steering magnet power supply control system for the TRISTAN AR.** Kubo, T.; Kabe, A.; Fukuma, H.; Ozaki, T.; Endo, K. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The closed orbit distortion of TRISTAN Accumulation Ring (AR) is corrected by the steering magnets (correction dipole magnets). These magnets are excited by the bipolar power supplies with the rated power of about 1 KVA. The power supplies are controlled remotely through the serial camac dataway. The camac modules which include the microprocessor are developed for this system and these modules send out the reference current patterns to the individual power supply.

7194 (DOE/ER/40238—1, pp 3787-3789) **Details of the cryogenic system for the Cornell superconducting R.F. beam tests.** Kirchgessner, J.; Demjanic, P.; Henderson, C.; Herb, S.; Mistry, N.; Phillips, L.; Walters, J. (Cornell Univ., Ithaca, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

During the course of the most recent and past Superconducting RF beam tests in CESR, various techniques and concepts were developed in the implementation of the cryogenic system. Some of these items will be described and will include, the long liquid helium transfer line, the liquid phase separation, the liquid nitrogen cooling system, feeding the waveguide heat exchangers, the JT valve, the temperature regulation and pumping system, the overall control and monitoring system, large and many indium seals, and mechanical details of the cryostat vessel.

7195 (DOE/ER/40238—1, pp 3792-3794) **Vacuum system for the Argonne 6 GeV synchrotron light source.** Wehrle, R.; Moenich, J. (Argonne National Lab., IL). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The ANL vacuum system for the 6 GeV light source storage ring features non-evaporable strip getter pumps for uniform pumping around the ring within a gas desorption antechamber, and it also features lumped getter pumping directly under and above crotch radiation absorbers that are positioned after each bending magnet. Based on experiments at ANL in 1980 and by others, the technical and economical advantages have been established for the use of the distributed NeG pumps of non-magnetic strips coated with a non-evaporable Zr Al getter matrix. The NeG strip pump lifetime approaches ten years. The antechamber improves the isolation of the gas desorption process from the main beam chamber and beam. The combination of these vacuum techniques; the NeG strip getter pumps, the gas desorption antechambers, and the lumped ion and lumped getter pumping provide a unique and reliable system for maintaining long beam lifetime.

7196 (DOE/ER/40238—1, pp 3795-3796) **Surface conditioning of synchrotron radiation source to improve beam lifetime.** Chou, T.S. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Surface cleanliness is of prime importance to achieve the desirable vacuum condition for long beam lifetime in all synchrotron radiation sources. The Photon Factory at KEK resolved the severe gas load from synchrotron radiation by in-situ Ar glow discharging the whole storage ring. Sufficient experience had been gained in the past two years operation on the synchrotron radiation source, especially on the VUV ring of the National Synchrotron Light Source (NSLS), to allow the authors to decide to glow discharge the VUV ring. In hoping to obtain higher circulating current and to reveal the cause of lifetime limitation, a better understanding of the beam loss mechanism is needed. Photodesorption is the major gas load in all existing electron (positron) storage rings. It is generally believed that these photodesorbed species (neutral and charged) provide the major loss mechanism to lessen the beam lifetime. The interaction of these species to the beam give rise to the various loss mechanisms, such as multiple Coulomb scattering, single scattering, bremsstrahlung and ion trapping. All these mechanisms has been under intense study at NSLS. This report only describes the result of surface condition and beam lifetime.

7197 (DOE/ER/40238—1, pp 3809-3811) **Operational characteristics of the TRISTAN accumulation ring vacuum system.** Momose, T.; Narushima, K.; Kanazawa, K.; Mizuno, H.; Watanabe, H.; Ishimaru, H. (National Lab. of High Energy Physics, Ibaraki-ken, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The operational characteristics of the TRISTAN vacuum system is described. The vacuum system is made of aluminum alloys using specially extruded aluminum pipes. The best base pressure, on the order of $10^{-8}$ Pa, was obtained without any baking or discharge cleaning. The thermal gas desorption rate of the aluminum chambers was on the order of $10^{-10}$ Pa.l/s.cm$^2$. For a time integrated beam current of 13.5 A.h, the pressure rise due to synchrotron radiation was 2.1 x $10^{-8}$ Pa/mA and the maximum beam lifetime was about 2 hours at several mA. The pressure rise is approximately inversely proportional to the time integrated beam current and is initially proportional to the beam energy, changing after about 7 A.h, to being proportional to the square root of the beam energy. A pressure independent lifetime of 357 min was observed. The lifetime at higher beam currents is proportional to the time integrated beam current. No thermal problems due to synchrotron radiation were observed. Corrosion due to high energy radiation in the presence of humidity was found in the aluminum windows for X-rays and γ-rays. Heating problems due to wall current discontinuities did not occur in the dual flat mirror surface seal type gate valves made of aluminum alloys. They were observed in current transformer, in the ceramic chambers, and in a normal, Viton sealed gate valve.

7198 (DOE/ER/40238—1, pp 3821-3823) **Investigation of the Touschek effect in VUV electron storage ring.** Miyahara, Y.; Nishimura, H. (Univ. of Tokyo, Japan). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The lifetime of stored electron beam current due to the Touschek effect was studied experimentally in the SOR-RING, a 400 MeV electron storage ring. From the measurement of the beam size and the lifetime, it is found that the theoretical expression of the lifetime is quite accurate for a flat beam, but some corrections are necessary for a round beam.

7199 **Comparison between theoretical predictions and tracking.** Ruggiero, A.G. (Argonne National Lab., IL, USA). *Particle Accelerators;* 19: No. 1-4, 157-179(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

The beam-beam interaction in a proton-antiproton collider has been an outstanding issue for some time. Several theoretical predictions have been made which range from the appearance of single beam-beam-driven resonances to the onset of stochasticity and Arnol'd diffusion and the presence of chaotic trajectories. All these effects would cause a limit on the maximum strength of the beam-beam interaction, the so-called beam-beam tune shift, and speculative values have been suggested for this parameter ranging from as low as 0.0005 to as large as a significant fraction of unity. The lower limit could be caused in a more complicated situation where the external focusing forces that keep the two beams in the storage ring are also modulated in time. In the work discussed here, these theoretical predictions have been compared with extensive computer tracking where the motion of the particles is followed over long periods of time. Though it is indeed possible to observe the formation of several resonances, the onset of connected stochasticity seems to occur at too large a beam-beam tune shift to be of any practical relevance. Moreover, no Arno'd diffusion has been observed in regimes of any practical significance. Chaotic trajectories have been found to embed the phase space in disconnected regions of appreciable extension. They increase considerably in number when time modulation of external focusing forces is added.

# 44 INSTRUMENTATION

## 4401 Radiation Instrumentation

*REFER ALSO TO CITATION(S) 6581, 7595, 7599, 7601, 7670, 7703*

7200 **(ANL-HEP-CP—86-64) Soudan 2 detector as a time-projection calorimeter.** Allison, W.W.M.; Alner, J.; Ambats, I.; Ayres, D.; Barr, G.D.; Barrett, L.; Brooks, C.B.; Cobb, J.H.; Cockerill, D.; Courant, H. (Argonne National Lab., IL (USA); Minnesota Univ., Minneapolis (USA); Oxford Univ. (UK); Rutherford Appleton Lab., Chilton (UK); Tufts Univ., Medford, MA (USA)). 1986. Contract W-31-109-ENG-38. 22p. (CONF-860701—45). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001505.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The Soudan 2 Nucleon Decay Detector uses Hytrel plastic tubes to cause ionization electrons to drift up to 50 cm prior to gas multiplication and collection. The drift tubes are embedded in a matrix of thin steel sheets. Readout is accomplished by flash digitizers in a system with distributed intelligence. This design is usable as a general-purpose calorimeter in which 3 spatial coordinates and pulse height are measured at all points where ionization occurs. Several 4.3 ton modules of this detector have now been studied in detail. We will present information about the detector performance and its dependence on manufacturing tolerances.

7201 **(BNL—38480) Measurement of the quantum efficiency of TMAE and TEA from threshold to 120 nm.** Holroyd, R.A.; Preses, J.M.; Woody, C.L.; Johnson, R.A. (Brookhaven National Lab., Upton, NY (USA); Cincinnati Univ., OH (USA)). 1986. Contract AC02-76CH00016. 17p. (CONF-860701—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86015146.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Several existing and planned high energy physics experiments incorporate detectors which use either TMAE (tetrakis-dimethylaminoethylene) or TEA (triethylamine) as their photosensitive agent. Understanding the operation of these devices requires knowledge of the absolute photoionization quantum efficiencies and absorption lengths of TMAE and TEA. In an experiment performed at the National Synchrotron Light source at Brookhaven National Laboratory, we have measured these parameters from 120 nm to 280 nm. The quantum efficiencies were normalized to the known photoionization yields of benzene and cis-2-butene. The results of these measurements and details of the experiment are presented in this paper.

7202 **(CEA-CONF—8311) Performance characterizations of X-ray streak camera.** Stradling, G.L.; Cavailler, C.; Launspach, C. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Sep 1986. 30p. (CONF-860950—2). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750263.

From 17. international congress on high speed photography and photonics; Pretoria, South Africa (1 Sep 1986).

These results have been obtained at the Centre d'Etudes de Limeil-Valenton on Astarte experiment and Ketjak laser with a C 650 X soft X-ray streak camera. This camera has been designed in Limeil and includes THOMSON-CSF avalanche transistors sweep circuit. It has been built around bilamellar P 650 tube designed by LEP laboratory and RTC company.

7203 **(CONF-860168—6) Scintillating fiber tracking techniques.** Ruchti, R. (Notre Dame Univ., IN (USA)). Feb 1986. Contract AC03-84ER80145. 11p. (UND-HEP—86-RR02). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000596.

From Workshop on observable standard model physics at the SSC; Los Angeles, CA, USA (15 Jan 1986).

The current status of the field of scintillating fiber detection and tracking is briefly reviewed, and avenues for further work are

suggested. Attention is given to the core material, cladding material, and extra-mural absorber to be used in the scintillating fibers, as well as to the properties of attenuation length, radiation resistance, and fiber profile. Some examples are given of successful recording of tracks and interactions. Current developments are mentioned in relation to plastic and glass fibers and liquid capillaries. (LEW)

7204 **(CONF-861007—4) New method of gamma dose-rate measurement using energy-sensitive counters.** Kopp, M.K.; Valentine, K.H.; Williams, J.A.; Bamberger, R.H. (Oak Ridge National Lab., TN (USA); Georgia Inst. of Tech., Atlanta (USA)). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002174.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A new concept of charge quantization and pulse-rate measurement was developed to monitor low-level gamma dose rates using energy-sensitive, air-equivalent counters. Applying this concept, the charge from each detected photon is quantized by level-sensitive comparators so that the resulting total output pulse rate is proportional to dose rate. The concept was tested with a proportional counter and a solid-state detector for wide-range dose-rate monitoring applications. The prototypic monitors cover a dose-rate range from background radiation levels 10 μR/h) to 10 R/h.

7205 **(CONF-8511150—12) Muon trigger studies.** Hedin, D. (State Univ. of New York, Stony Brook (USA)). 2 Apr 1986. Contract AC02-80ER10699. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002215.

From Workshop on triggering, data acquisition and computing for high energy/high luminosity hadron-hadron colliders; Batavia, IL, USA (11 Nov 1985).

The trigger rates and efficiencies for both beam-beam events and random cosmics have been recalculated using the GEANT related programs. Only rates in the central region have been looked at. (LEW)

7206 **(DOE/ER/10578—6) [Hyperfine structure and isotope shift measurements of short lived elements by laser spectroscopy].** Schuessler, H.A. (Texas A and M Univ., College Station (USA). Dept. of Physics). [1986]. Contract AS05-80ER10578. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002447.

The aim of this research is to determine nuclear moments and charge distributions of short-lived isotopes produced both on-line and off-line to a nuclear facility. These measurements give detailed information on the nuclear force and are used to test current nuclear models. The small amounts of nuclei which can be produced off stability constitute the challenge in these experiments. Presently mainly neutron-rich isotopes are being studied by three ultrasensitive high-resolution laser techniques. These are collinear fast ion-beam laser spectroscopy, stored-ion laser spectroscopy and fluorescence spectroscopy. 5 figs.

7207 **(DOE/ER/10713—7B) Studies of $e^+e^-$ interactions: Progress report, August 1, 1985-July 31, 1986.** Abashian, A.; Gotow, K. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Sep 1986. Contract AS05-80ER10713. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002432.

This report is intended to summarize the activities of the VPI particle physics group working on the preparation of the AMY experiment at TRISTAN. The group is largely responsible together with groups from Rutgers and University of California, Davis for the construction, testing, installation and operation of a large, 15 ton, 15 radiation length cylindrical electromagnetic shower counter which will be installed inside a solenoidal magnet of 3 tesla.

7208 **(EGG—10282-2100) Ultra low noise, low power hybrid preamplifier for x-ray spectrometry.** Iwanczyk, J.S.; Dabrowski, A.J.; Dancy, B.W.; Patt, B.E.; DeVore, T.M.; Del Duca, A.; Ortale, C.; Schnepple, W.F.; Barksdale, J.E.; Thompson, T.J. (University of Southern California, Marina Del Rey (USA). Inst. of Physics; EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations; EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Las Vegas Operations). 1986. Contract AM03-76SF00113;AC08-83NV10282. 4p. (CONF-861007—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002204.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A hybrid preamplifier for use with high resolution $HgI_2$ x-ray detectors has been developed. Full scale discrete component circuits were tested, and the final design was hybridized as a standard 20-pin dip package. The preamplifier can be configured to operate as a resistor or pulsed feedback mode device. In the pulsed light feedback mode the electronic noise measured by the pulser method with the input transistor cooled to approximately -30°C was 19.6 electrons RMS. The equivalent input noise at room temperature was 22 electrons RMS, and the power consumption was 220 mW. In the resistor feedback mode corresponding values of 30 electrons RMS and 200 mW were measured.

7209 **(LAL-RT—86-01) Dimensioning of a high pressure x-camera window for an homogeneization method (application to GALAL).** Le Meur, G. (Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire). Jan 1986. 27p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750265.

This document aims at showing an homogeneization method applied to the calculation of a high pressure X-camera window, realized for the GALAL. This method applies to periodical structures, the period dimensions being low in front of those of the whole structure (composite materials, perforated materials, etc...).

7210 **(N—86-31031) Support of the balloon-borne ultraviolet stellar spectrograph. Final report.** Timothy, J.G. (Stanford Univ., CA (USA)). May 1986. 14p. (NASA-CR—177152; NAS—1.26:177152). NTIS, PC A02/MF A01.

A (256 x 1024)-pixel imaging ultraviolet Multi-mode Microchannel Array (MAMA) detector system for flight was fabricated, evaluated, and environmentally tested for flight on the Balloon Borne Ultraviolet Stellar Spectrograph (BUSS). The goal of the program was to replace the existing SEC Vidicon with the pulse-counting MAMA detector in order to, first, improve the overall sensitivity of the BUSS telescope and spectrograph for observations of stars down to m sub v = 7 and fainter, and, second, to improve the spectral resolution and wavelength accuracy by eliminating the image drifts in the Vidicon caused by magnetic field effects. A sealed MAMA detector tube structure employing a remotely processed photocathode mounted on a window in proximity focus with the front face of the MCP was developed to avoid contamination produced by a noisy and unstable device. The configuration of the BUSS detector system in its flight ready configuration is shown. The quantum efficiency curve for the semi-transparent $Cs_2Te$ photocathode is also shown.

7211 **(SLAC-CN—349) Radiation transmission measurements on a small warm ion chamber.** Jenkins, T.M. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). 9 Oct 1986. Contract AC03-76SF00515. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002666.

Measurements were made on a small warm ion chamber (WIC) to determine if high energy neutrons travelling up the gaps of the SLD end plates may pose a problem during an accident. Measurement results are given through gaps, through the WIC body thickness. Photon and neutron penetration through end caps and the main body of the WIC are then extrapolated to apply to the SLD. (LEW)

7212 (UCRL—50007-85, pp 34-42) **WOTAMS: a transuranic aerosol measurement system for workplace, stack, or fence-line air monitoring.** Prevo, C.T.; Biermann, A.H.; Kaifer, R.C.; Sawyer, S.R.; Rueppel, D.W.; del Vasto, R.M.; Merrill, T.J.; Sawyer, D.L.; Salbeck, R.E. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

A compact WOrking-area Transuranic-Aerosol Monitoring System (WOTAMS) was developed with a sensitivity of better than 0.5 MPC-H for $^{239}$Pu, using alpha spectroscopy. A detector, mounted in the inlet pipe to monitor a filter paper during the collection, responds immediately if it senses a release of radioactivity; then, after a time specified by the operator, the filter is moved to the vacuum chamber for more-sensitive offline analysis. A microcomputer controls the filter transport, operates as a 256-channel PHA, performs calculations, checks calibration, and drives a matrix display. The particle deposition and loss occurring in WOTAMS were studied by investigating the dependence of losses in the sampling inlet and real-time alpha detector areas with respect to particle size. Further, the uniformity of particle deposition on the collection filter was determined to ascertain the effectiveness of the detector and collection filter configuration. Results indicate that particle losses in the WOTAMS are less than 0.5% for particle diameters in the 1-7 $\mu$m range.

7213 (UCRL—50007-85, pp 79-87) **Use of CR-39 foils for personnel neutron dosimetry: improved electrochemical etching chambers and procedures.** Hankins, D.E.; Homann, S.G.; Westermark, J. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

The electrochemical etching procedures for the new dosimetry system that uses foils of CR-39 plastic has been improved. During 1985, the etching chambers were modified to correct several problems and the changes to the etching procedures were studied, which gave a more uniform track density and size. The currently recommended etch parameters are given. A new generation of CR-39 material from the manufacturer proved to have a considerably lower background track density and a higher sensitivity; the new foils are also more uniform in thickness, which eliminates the need to numerically compensate for thickness variations. The energy dependence of the CR-39 using monoenergetic neutrons from accelerators at Battelle Northwest Laboratories and at Los Alamos National Laboratory was determined. Some variation was found in the energy dependence, but it is believed this was caused by changes in the etching procedures and by uncertainties in the fluences of the neutrons from the accelerators. A means by which the counting of CR-39 tracks may be automated is suggested; this would be very useful in adapting the CR-39 dosimetry system to large-scale use.

7214 (UCRL—50007-85, pp 88-91) **Study of environmental effects on CR-39.** Hankins, D.E.; Salamon, M.; Westermark, J. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

A study of environmental effects on foils of CR-39 plastic used in the new personnel neutron dosimetry system is discussed. The results from the study show that the decreasing sensitivity of CR-39 foils to neutrons and the fading of latent tracks are accelerated by exposure to elevated temperatures and oxygen levels, and UV light. Moisture variations have no effect on the fading of tracks or the sensitivity of the foils. The results indicate that CR-39 foils should be stored in a dark area near 0°C. When worn as a personnel neutron dosimeter, the CR-39 should be packaged to keep it from being exposed to light, and the wearer should be instructed to avoid subjecting the dosimeter to high temperatures.

7215 (UCRL—50007-85, pp 93-99) **Development of a neutron detector for criticality alarm systems.** O'Dell, A.A.; Thorngate, J.H. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Three potential neutron detectors were studied to evaluate for use in criticality alarm systems. The counting elements in all three detector types are based on thermal-neutron interactions in $^{6}$Li. Each detector must be small (~ few cm), must operate at a low bias voltage (~ 10 V), and must have high detection sensitivity. Since the counting element in each detector is enclosed by a 10-in.-diameter spherical polyethylene moderator, the detector responds proportionally to the biological hazard in a neutron radiation environment rather than to the incident neutron flux. In addition to acting as a criticality alarm, such a neutron detector can serve the functions of continuous and historical monitoring of operational radiation levels, acting as a reliable criticality accident alarm, and monitoring post-accident radiation levels. These three detector types were tested at the Los Alamos National Laboratory SHEBA and GODIVA assemblies, using steady-state runs to calibrate the detectors at selected high rates and using long-period reactor excursions to check for detector linearity and saturation effects. With the results of these irradiation tests, promising ways were identified to improve these designs to produce more sensitive and reliable neutron detectors for criticality safety applications.

7216 **(N—86-28728) Dynamic method for measuring the non-linearities of photoelectric detectors.** Jung, H.J. Translated from *Zeitschrift fuer Angewandte Physik ;* **30**: No. 5, 338-341(1970). 16p. (NASA-TM—88464; NAS—1.15:88464). NTIS, PC A02/MF A01.

The photocurrent of a nonlinear radiation detector contains a signal with the frequency omega sub 1-omega sub 2 when exposed to two chopped light beams with the chopper frequencies omega sub 1 and omega sub 2. The amplitude of the intermodulation signal is proportional to the non-linearity. So it is possible to measure nonlinearities in a direct way without evaluating small differences of large quantities. The method shown requires less stability of light sources than classical methods. A dependence of the intermodulation signal on the chopper frequencies gives additional information about time dependent nonlinearities.

## 4403 Miscellaneous Instruments

*REFER ALSO TO CITATION(S) 6691, 6883, 6902, 7011, 7019, 7238, 7829*

7217 **(AD-A—171539/0/XAB) Josephson-effect detectors of microwave and far-infrared radiation. Final technical report, 1 December 1984-31 May 1986.** (California Univ., Berkeley (USA). Dept. of Physics). 31 May 1986. 4p. NTIS, PC A02/MF A01.

This contract terminates nearly ten years of Navy support for the invention and development of superconducting quasi-particle heterodyne receivers for millimeter-wavelength radiation. Quantum effects such as mixer conversion gain and noise comparable to the limit set by the Heisenberg uncertainty principle have been experimentally observed. Mixer response at 36 and 90 GHz has been studied as a function of parameters such as RF and IF embedding impedance, local oscillator power, bias voltage, junction I-V curve, and operating temperature. Comparisons have been made with SIS mixer theory and good agreement has generally been found. These mixers are being used full time in heterodyne receiver systems at several radio astronomical observatories. They are the lowest noise millimeter wave receivers available today.

7218 **(CEA-CONF—8437) Optical fiber sensors for object and people detection.** Blanc, F.; Bonnejean, C.; Boisde, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 7p. (In French). (CONF-8604264—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750251.

From Workshop on industrial applications of optical fiber sensors; Gif-sur-Yvette, France (16 Apr 1986).

After a quick presentation of the existing systems, 2 realizations with optical fibers are described: one for object detection in nuclear medium, the other for intrusion.

7219 **(CONF-861114—19) Ion-induced x-ray studies with a high luminosity von Hamos crystal spectrometer.** Vane, C.R.; Smith, M.; Raman, S.; Heard, J.; Walkiewicz, T. (Oak Ridge National Lab., TN (USA); Edinboro State Univ., PA (USA)). 1986. Contract AC05-84OR21400. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002190.

From 9. international conference on application of accelerators in research and industry; Denton, TX, USA (10 Nov 1986).

A high-resolution, high-efficiency, von Hamos geometry, Bragg crystal x-ray spectrometer has been developed and mounted on a beamline at the Holifield Heavy Ion Research Facility at the Oak Ridge National Laboratory. Measurements have been made of K and L x-rays emitted from a variety of targets and projectiles. Instrument performance characteristics are reported here along with spectra from fast projectile ions and very low intensity target emission - areas of measurement for which this spectrometer is especially suitable.

7220 **(EGG—10282-1120) Calibration system for sub-100-ps relative timing.** Whitcomb, B.M.; Flurer, R.L.; Woo, L.C.; Toms, K.W.; Ogle, J.W. (EG and G Energy Measurements, Inc., Las Vegas, NV (USA); Los Alamos National Lab., NM (USA)). 1986. Contract AC08-83NV10282. 6p. (CONF-8609127—13). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002301.

From SPIE's fiber LASE '86; Cambridge, MA, USA (14 Sep 1986).

Due to the unusual experimental conditions experienced at the Nevada Test Site (NTS), unique requirements are imposed on calibration systems. This paper describes a fiber optic system which was used to calibrate a recent experiment. Eight photodiodes (PD's) were used as signal detectors. The experiment required that the relative timing between the signal channels be known to +-50 ps. A multiple fiber system was used to provide sufficient signal amplitude to the detectors without stimulating Raman. By the use of this calibration technique, relative timing to +-35 ps was achieved.

7221 **(EGG—10282-1121) Characterization of 820-nm single mode fibers.** Flurer, R.L.; Cordi, A.J.; Colburn, C.W.; Whitcomb, B.M.; Ogle, J.W. (EG and G Energy Measurements, Inc., Las Vegas, NV (USA); Los Alamos National Lab., NM (USA)). 1986. Contract AC08-83NV10282. 8p. (CONF-8609127—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002300.

From SPIE's fiber LASE '86; Cambridge, MA, USA (14 Sep 1986).

Increasing interest in the use of high bandwidth optical diagnostic measurement systems at the Nevada Test Site (NTS) has prompted the use of single mode fiber (SMF). In an effort to improve the time response of experimental systems designed for use in the 800- to 900-nm spectrum, SMF optimized for 850-nm operation has been obtained. Experimental systems to characterize this fiber have been developed. Measurements to determine the fibers' bandwidth, material dispersion, mode field diameter (MFD), cut-off wavelength, numerical aperture (NA), and spectral attenuation have been completed. These experimental data are presented in the text.

7222 **(N—86-28729) 1700°C optical temperature sensor. Final report.** Mossey, P.W.; Shaffernocker, W.M.; Mulukutla, A.R. (General Electric Co., Cincinnati, OH (USA)). Jul 1986. 168p. (NASA-CR—175108; NAS—1.26:175108). NTIS, PC A08/MF A01.

A new gas temperature sensor was developed that shows promise of sufficient ruggedness to be useful as a gas turbine temperature sensor. The sensor is in the form of a single-crystal aluminum oxide ceramic, ground to a cone shape and given an emissive coating. A lens and an optical fiber conduct the thermally emitted light to a remote and near-infrared photodetector assembly. Being optically coupled and passive, the sensor is highly immune to all types of electrical interference. Candidate sensors were analyzed for optical sensor performance, heat transfer characteristics, stress from gas loading. This led to the selection of the conical shape as the most promising for the gas turbine environment. One uncoated and two coated sensing elements were prepared for testing. Testing was conducted to an indicated 1750 C in a propane-air flame. Comparison with the referee optical pyrometer shows an accuracy of + or - 25 C at 1700 C for this initial development. One hundred cycles from room temperature to 1700 C left the sapphire cone intact, but some loss of the platinum, 6% rhodium coating was observed. Several areas for improving the overall performance and durability are identified.

7223 **(N—86-31030) High accuracy fuel flowmeter. Final report.** (General Electric Co., Wilmington, MA (USA)). 1986. 346p. (NASA-CR—174869; NAS—1.26:174869). NTIS, PC A15/MF A01.

All three flowmeter concepts (vortex, dual turbine, and angular momentum) were subjected to experimental and analytical investigation to determine the potential portotype performance. The three concepts were subjected to a comprehensive rating. Eight parameters of performance were evaluated on a zero-to-ten scale, weighted, and summed. The relative ratings of the vortex, dual turbine, and angular momentum flowmeters are 0.71, 1.00, and 0.95, respectively. The dual turbine flowmeter concept was selected as the primary candidate and the angular momentum flowmeter as the secondary candidate for prototype development and evaluation.

7224 **Experimental study of microwave radiation from a non-relativistic rotating electron beam.** Chojnacki, E.; Destler, W.W. (Electrical Engineering Dept., Univ. of Maryland, College Park, MD 20742). pp 54 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Present experiments obtain radiation at the 10/sup th/ harmonic of the cyclotron frequency (X-band) using a magnetron-type slotted wall conducting boundary. The basic radiation mechanism is the electron cyclotron maser instability, and the slotted wall waveguide acts to enhance this instability at a chosen azimuthal (cyclotron) harmonic. Two different slotted waveguide structures are being studied experimentally. The first is a 10-slot structure operating in the $2\pi$ mode and the second is a 20-slot structure operating in the $\pi$ mode. Both structures have beam-waveguide interactions resulting in radiation at the 10/sup th/ harmonic. Theoretically the $\pi$ mode structure has lower threshold beam power requirements for start oscillation. Experimental comparisons are presented with respect to start oscillation beam power and final saturated microwave power. In another experiment, the rotating $\xi$-layer will be injected into a smooth wall cylindrical waveguide with an azimuthally periodic magnetic wiggler field present. A beat wave coupling of the wiggler field and electromagnetic waveguide field is expected to give microwave radiation at high harmonics of the electron cyclotron frequency. Design considerations and preliminary experimental results are presented.

7225 **Current density measurements in the virtual cathode oscillator.** Clark, M.C.; Thode, L. (Sandia National Labs., Albuquerque, NM 87185). pp 55 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Microwave generation in the Virtual Cathode Oscillator (VCO) is thought to be due to the bunching of two distinct particle distributions. The first distribution is that of the electrons which are reflected off of the virtual cathode and back into the anode-cathode gap. These particles are trapped between the two potential wells forming a geometry very similar to that of the standard Reflex Klystron. The second distribution is that of the virtual cathode which is itself inherently unstable. These two components can produce microwaves at different frequencies depending on the particular geometry. These predictions have yet to be verified by direct experiment. The authors have made radially and temporarily resolved measurements of the electron beam current density in a conventional (non-magnetized) VCO using a miniature, directional Faraday cup. The VCO was operated on a transformer driven elec-

tron beam generator which produced a 500 kV, 40 kA, 70 ns electron beam. Diode parameters were chosen to cause VCO operation below 2 GHz so that signals could be recorded directly on a Tektronix 7104 oscilloscope and so that probe damage could be minimized.

7226 **A repetitively-pulsed virtual cathode oscillator.** Earley, L.M.; Clark, M.C.; Rohwein, G.J.; Clark, R.S.; Wharton, C.B. (Sandia National Labs., Albuquerque, NM 87185). pp 56 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—). Contract AC04-76DP00789.

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The authors have successfully operated a non-magnetized virtual cathode oscillator (VCO) at pulse repetition frequencies (prf's) of 1 to 10 Hertz for bursts of 10 to 200 pulses with a peak power of 100 MW (7 Joules/pulse). This is the first VCO to be run at 10Hz in the United States. The VCO operated in cylindrical geometry with a planar diode consisting of a cathode covered with Rayon velvet and a mesh anode of either stainless steel or copper. The electron beam was generated with a 6-ohm water-insulated coaxial transmission line which was charged to -900 kV by a repetitively-pulsed dual-resonance transformer. The diode voltage was measured to be-500 kV. The A-K gap was varied from 1 to 2 cm, while the cathode diameter was varied between 10 and 12.5 cm. The average beam current in these experiments was 30 kA. The microwave output was extracted axially through a single circular waveguide. The VCO generated microwaves in the TM/sub 01/ mode at frequencies from 2.5 to 3.5 GHz. The frequency was measured with a heterodyne receiver. The pulse width was between 60 and 100 ns. The power was measured with the two directional couplers, and the pulse energy was measured by a broadband six channel calorimeter which was able to measure both the energy of a single pulse and the total energy of a burst.

7227 **Backward wave oscillator (BWO): Experiments and electromagnetic particle-in-cell code simulations.** Earley, L.M.; Marder, B.M.; Roose, L.D. (Sandia National Labs., Albuquerque, NM 87185). pp 58 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—). Contract AC04-76DP00789.

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Significant progress has been recently made in extending the applicability of particle codes to high power microwave sources. The authors report on the use of a new code in analyzing relativistic BWOs and compare these results with both in-house and published experimental data. The code is more efficient than other similar codes, which allows extensive parameter variations of the source to be explored rapidly. The interaction between a relativistic annular electron beam and a rippled wall slow wave structure has been extensively investigated experimentally by many groups, but optimizing this interaction is difficult. The interaction is determined by the geometry of the structure and the characteristics of the beam. Saturation of this interaction is an important condition. Experiments have been carried out to explore several key parameters of the slow wave structure and the electron beam. The following structure parameters were varied: length, 10 to 30 cm, average diameter, 2.5 to 3.5 cm, and ripple depth, 0.2 to 0.8 cm. The beam current (1 to 10 kA) as well as the diameter of its annulus (0.8 to 1.8 cm) was varied for each structure tested. The axial magnetic field (5 to 30 kG) confining the beam was also varied. The diode voltage for all cases was approximately 1 MV. The output power and frequency of each condition was measured using several methods. The energy of the pulse was also measured with a calorimeter.

7228 **A comparison of small-orbit and large-orbit gyroklystrons for a high peak power application.** Lawson, W.; Latham, P.E. (Lab. for Plasma and Fusion Energy Studies, Univ. of Maryland, College Park, MD 20742). pp 54 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Detailed here are both the characteristics of the gun design and the gyroklystron circuit for a 500 keV beam. An electron trajectory code (with self-fields) is used to simulate motion in the diode and compression region while a single particle code is used to treat the transition region. The authors demonstrate that the same gun can produce either a small-orbit beam suitable for interaction with a TE/sub 01//sup o/ cavity mode or a large-orbit beam suitable for interaction with a TE/sub 31//sup o/ cavity mode. A non-linear, partially self-consistent code is used to simulate the interaction of each type of beam with an appropriate four-cavity gyroklystron circuit. A detailed comparison of relevant characteristics, including peak gain and efficiency, performance degradation with increasing velocity spread, and AM and FM sensitivities to voltage and current fluctuations, is made. Finally, the properties of large-orbit gyroklystrons operating at 10 GHz in the fundamental mode and at 150 GHz at the 15th cyclotron harmonic are analyzed with the linear code.

7229 **Recent results on the design of a high peak power, x-band gyroklystron.** Latham, P.E.; Calame, J.; Granatstein, V.L.; Lawson, W.; Striffler, C.D.; Williams, F.J. (Electrical Engineering Dept., Univ. of Maryland, College Park, MD 20742). pp 55 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The authors present the theoretical and experimental design of a 10 GHz multi-cavity gyroklystron amplifier operating in the TE/sub 011//sup o/ mode. The nominal beam power of 80 MW is expected to result in approximately 30 MW of microwave power. The beam has a pulse length of 1 μ/sup s/, a perpendicular to parallel velocity ratio of 1.5, and a current variation of 100-200 A while maintaining an axial velocity spread of less than 10%. A partially self-consistent numerical code is employed to optimize efficiency and study phase stability. The code allows a non-uniform magnetic field and uses the exact cold cavity fields in the buncher cavities. In the output cavity, the effect of beam loading on the field profile is included. To model the spread in axial velocity produced by a realistic MIG, the authors let the axial velocity depend on guiding center. Cold test results from the three types of cavities are presented. The techniques used to lower the unloaded Q's of the buncher cavities and to inject the TE/sub 011//sup o/ mode into the input cavity are emphasized. The suitability of using drift tubes comprised of alternating rings of conductor and microwave absorber is examined. Detailed designs of the modulator and the magnetic field coils are also presented. Concepts for the beam dump, output window, and microwave diagnostics are described.

7230 **Design of a magnetized virtual cathode microwave generator.** Kwan, T.J.T.; Davis, H.A.; Bartsch, R.R.; Stringfield, R.M.; Sherwood, E.G. (Los Alamos National Lab., Los Alamos, NM 87545). pp 67 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Microwave generation by electron beams in virtual cathode configurations can achieve significant power levels. However, most designs inherently have two competing mechanisms generating microwaves; namely the oscillating virtual cathode and the reflexing electrons. Further, they tend to interfere destructively with each other. Microwave production by oscillating virtual cathodes suffers from rapidly decreasing efficiency as the energy spread or angular scattering increases. In the configurations considered to date, the incoming electron beam can be adversely affected by the reflexing electrons. Specifically, the reflexing electrons subject the electron beams to two-stream instability, causing considerable heating of the electron beam. Further, the space-charge of the reflexing electrons can cause the diode impedance to fluctuate, resulting in oscillations of the electron beam energy. The authors have followed a novel idea to remove these undesirable effects in the design of a high-power, narrow-band, monochromatic microwave

source based on oscillating virtual cathodes. The design uses a thick graphite anode with appropriate slit in combination with an axial magnetic field of suitable strength to essentially eliminate the reflexing electrons. The annular electron beam is guided through the anode slit by the magnetic field, and many of the reflected electrons are absorbed by the anode because of the transverse momentum induced by the self fields. The design has been numerically simulated using the two-dimensional particle-in-the-cell codes, CCUBE and ISIS.

7231 **Observation of high-power microwave emission from strongly magnetized virtual cathode sources.** Davis, H.A.; Bartsch, R.R.; Sherwood, E.G.; Stringfield, R.M.; Kwan, T.J.T. (Los Alamos National Lab., Los Alamos, NM 87545). pp 68 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The authors describe experiments designed to eliminate electron reflexing and exclusively use virtual cathode oscillations to generate high-power microwave radiation. This approach may lead to higher power levels, more monochromatic output and better mode control. They inject an intense beam (I=60 KA, V=3 MV, t=60 ns) along an axial guide magnetic field (0<B/sub z/<30 KG) into circular waveguide through a thin annular slot in an electron range-thick anode. The fields of the virtual cathode, which forms in the waveguide downstream of the anode, should scatter the reflected electrons preventing them from reentering the diode region through the slot. The experiment uses a 6.0-cm-diam cathode centered in a 10.8-cm-diam housing with anode-to-cathode spacings from 1.0 to 4.0 cm. The output waveguide diameter is 18.0 cm with the slot width being typically a few mm.

7232 **Radiation mechanism in virtual cathode tubes.** Thode, L.E.; Snell, C.M. (Los Alamos National Lab.). pp 67 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

It has been found that four mechanisms contribute to radiation generation: spontaneous and forced oscillating virtual cathode, reflexing electrons, and charge bunches flowing radially about the anode foil. It is the last mechanism that is the source of radiation. The frequency is determined by the beam plasma frequency and reflexing electron transient time. In an unmagnetized system the reflexing electrons exhibit the higher frequency.

7233 **The mildly relativistic electron-beam-driven orotron.** Walsh, J.; Garate, E.; Mukhopadhyay, P.; Cook, R.; Boudreaux, G.; Layman, R. (Dartmouth College, Hanover, NH 03755). pp 81 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Two basic types of Open Resonator Oscillators (Orotrons) can be defined. In one of them, a spherical mirror opposes a planar grating and the output coupling axis is normal to the grating. A second type, which is comprised of a planar grating terminated with cylindrical mirrors or other coupling structures, also shows promise as a mm- and shorter -wavelength source. The first type of structure supports a spherical Hermite-Gaussian mode which is cylindrically symmetric about an axis normal to the grating, while the second supports cylindrical nodes of the same general type. Experimental testing of a planar Orotron is under way. It has been operated over a beam voltage range from 35-200 KV and at beam currents between .8 and 15 A. The output power exceeds that available from coupled-cavity TWT's at comparable wavelengths (3-18 mm) and the tuning range is comparable to the lower-power, wide bandwidth helix TWT. A detailed comparison of the performance characteristics of the planar Orotron, the Vertical Orotron, and other competitive mm sources are presented.

7234 **Progress on high-power magnetrons and vircators.** Benford, J. (Physics International Co., 2700 Merced Street, San Leandro, CA 94577). pp 81 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The PI Microwave Group is studying two very different types of High-Power Microwave Sources: Relativistic Magnetrons and Virtual Cathode Oscillators. The vircator is a broad band tunable microwave source producing short pulses with a 1 GHz bandwidth. The frequency is tunable using the AK gap, efficiency is $\approx$ 1%. In a high current diode the dominant radiation mechanism is the oscillation of the virtual cathode, not the reflexing of electrons. Radiation occurs after diode pinch and is accompanied by partion of the electron population into a reflexing electron component and a propagating beam component. Recent experiments have studied the interaction of the vircator with a resonant cavity. The cavity suppress frequencies not in resonance with the cavity modes and thereby limits bandwidths to less than 100 MHz. Overall efficiency is improved by a factor of about 4 by non-linear feedback interaction between the cavity and the oscillating virtual cathode. Magnetrons are a fixed frequency, high-power source with a narrow bandwidth. Recent experiments have extracted power from six waveguides of a 2.8 GHz device operating in the $\pi$ mode. Configurations using this multi-arm device for production of propagating pulses are described.

7235 **An induced resonance electron cyclotron (IREC) quasi-optical maser.** Sprangle, P.; Tang, C.M.; Serafim, P. (Naval Research Lab.). pp 82 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

A novel radiation source configuration, based on an electron cyclotron interaction mechanism, is proposed and analyzed. The proposed configuration is referred to as an induced resonance electron cyclotron (IREC) quasi-optical maser. This radiation source configuration has the unique features of being highly efficient and at the same time relatively insensitive to the detrimental effects of poor beam quality. A system of nonlinear coupled orbit equations, describing the dynamics of electrons in a spatially varying external magnetic field and the electromagnetic field of a steady state multiple mirror resonator, are derived and analyzed. The authors show that with the proper choice for the index of refraction, the high frequency cyclotron interaction can be made insensitive to a beam energy spread. The sensitivity to the beam's pitch angle spread in the IREC mechanism can be minimized. The necessary conditions on beam quality for high efficiency operation are derived and shown to be in good agreement with numerical solutions. Furthermore, they show that by appropriately tapering the magnetic field an induced resonance condition can be achieved which results in high interaction efficiencies. A comparison between the IREC maser and the cyclotron autoresonance maser (CARM) mechanism and configuration is made. It is anticipated that an efficient, high power millimeter, submillimeter and infrared radiation source can be realized with the IREC quasi-optical maser configuration.

7236 **A 100 MW magnetron injection gun for a 10 GHz gyroklystron.** Striffler, C.D.; Calame, J.; Granatstein, V.L.; Latham, P.E.; Lawson, W.; Reiser, M.; Park, G.S.; Williams, F.J. (Electrical Engineering Dept., Univ. of Maryland, College Park, MD 20742). pp 82 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

A 30 MW, 1 μs, 10 GHz amplifier is being developed for accelerator applications. The system considered is a gyroklystron employing a double anode Magnetron Injection Gun (MIG) rated at 100 MW. This presentation delineates the relevant gyroklystron properties and the subsequent procedures and methods used to achieve the final MIG design. The choice of operating mode and frequency in the gyroklystron dictates the geometry of the various cavities and drift tube sections, and thus, the mean radius of the an-

nular small orbit electron beam, beam voltage, and applied magnetic field. The authors use a set of adiabatic trade-off equations to obtain the geometry parameters and voltage settings of the double anode MIG. The operating range of magnetic field at the cathode is determined by balancing requirements on the peak electric fields and on the temperature-limited operation. Electric field limits are set as a result of breakdown, and operating near the space-charge limit results in poor beam quality.

7237 **High power vircator source development.** Sullivan, D.J. (Mission Research Corp., 1720 Randolph Road, SE, Albuquerque, NM 87106). pp 83 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The vircator in its modern form is an essentially new class of microwave tube. It has the attributes of conceptual simplicity, high output power capacity and wide tunability. Frequencies ranging from 800 MHz to over 40 GHz have been witnessed. These features have already been demonstrated experimentally at MRC, on a small scale. Furthermore, experimental work in other laboratories, and the results of particle code simulations, have clearly indicated that the vircator is a source of extraordinarily high power. Hence, it has some unique applications. The virtual cathode oscillator results when the beam current injected into a waveguide or cavity resonator exceeds the space-charge limiting current. The limiting current is defined by the beam energy and waveguide or resonator geometry. The lack of a stable steady state equilibrium for the beam under these conditions results in formation of a virtual cathode, which is a stable oscillatory state of the electron beam.

# 45 EXPLOSIONS AND EXPLOSIVES

## 4501 Chemical

7238 **Recent developments in Microshell-tipped optical fibers as high-pressure shock detectors.** Mayer, F.J.; Benjamin, R.F.; Maynard, R.L.; Musinski, D.L.; Schmerberg, N.W.; Wixom, M.R. (KMS Fusion, Ann Arbor, MI). pp 547-551 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper describes recent results from an ongoing development of Microshell-tipped optical fibers as high pressure shock wave sensors. The sensors are commonly referred to as optical pins by analogy to the standard electrical pins. The device is actually a miniaturized embodiment of the "flash-gap" shock detection scheme described by Walsh and Christian. Arrays of optical pins have been used in a variety of shock-sensing applications including ballistic impacts, detonation velocity measurements in explosives, and magneto-explosive generators.

7239 **Description of a new 63-MM diameter gas gun facility.** Sheffield, S.A.; Dugan, D.W. (Sandia National Lab., Albuquerque, NM). pp 565-570 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper describes a new light gas gun that is used in the study of shock initiation and shock properties of explosive materials. This gun was patterned after the 100-mm diameter gas gun at Washington State University. Several unique features have been designed into the facility to make it easier to control and use the gun and to improve shot turnaround time. These features are discussed in detail. Initial gun performance information is also presented.

7240 **Computer simulation of the effect of free surface reflection on shock wave propagation in water.** Kamegai, M.; Klein, L.S.; Rosenkilde, C.E. (Lawrence Livermore National Lab., Livermore, CA). pp 673-676 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper uses a computer simulation to study the behavior of a fluid which has been set into motion by a point explosion below a bounding free surface. The interaction between the incident shock wave and the reflected rarefaction signal is studied which, under certain conditions, can overtake the shock front. Onset criteria for the envelope which separates the region of irregular from that of regular rarefaction, the nonspherical shape of the shock front, and the pulse profile for several depths of burst covering both strong and weak shock interactions with the surface are discussed.

7241 **Dynamic and static compressibility of porous granular hexanitrosilbene.** Setchell, R.E.; Taylor, P.A. (Sandia National Labs., Albuquerque, NM). pp 871-876 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper undertakes both experimental and analytical studies of the compressibility behavior of hexanitrostilbene (HNS) under non-reactive conditions. The authors examine the compressibility of HNS materials having a range of initial grain size distributions. The results indicate that the compressibility of HNS materials depends not only on the initial porosity, but also on the microstructural features associated with that porosity. Equations are presented which provide a means of taking into account the influence of porosity and/or granularity on the initiation characteristics of pressed explosives by numerical simulation wavecodes.

7242 **Equilibrium shock and release properties of post-detonation mixtures of PBX-9404 LX-14, RDX, and TN.** Van Thiel, M.; Ree, F.H.; Sayer, J. (Lawrence Livermore National Lab., Livermore, CA). pp 883-889 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

The statistical mechanical model, CHEQ, has been used to calculate equilibrium properties of the detonation products of PBX-9404, LX-14, RDX, and TNT. The results are compared with experiment. The theoreticalexperimental comparison indicates good agreement for the HMX mixtures and RDX, except for CJ pressures. Such differences may be related to rate effects. The behavior of TNT products is qualitatively different because of the lower density range and larger carbon content. The shock data indicates some characteristics of carbon as formed in these hot mixtures. These characteristics are discussed.

7243 **POP plot and Arrhenius parameters for (110) pentaerythritol tetranitrate single crystals.** Dick, J.J. (Los Alamos National Lab., Los Alamos, NM). pp 903-907 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

Plane shock initiation sensitivity measurements for <110> single crystal pentaerythritol tetranitrate were extended to 20 GPa. The data of run distance versus input stress do not fall on the usual straight line on the Pop plot. From these data Arrhenius parameters were calculated. Computed activation energy was 6.4 kcal/mole, and the frequency factor was $5X10^9$/s. These are much lower than values obtained from isothermal heating experiments. These results can be used to support the idea that the uniaxial strain due to the shock leads to heterogeneous heating of the homogeneous material.

## 4502 Nuclear

*REFER ALSO TO CITATION(S) 6813, 7499*

**7244 (AD-A—171578/8/XAB) Defense Nuclear Agency Management Task Force. Final report.** (Defense Science Board, Washington, DC (USA)). Jun 1986. 88p. NTIS, PC A05/MF A01.

The Task Force was chartered to review present management authority and responsibilities, organizational structure, and staffing of the Defense Nuclear Agency. The Task Force makes several recommendations aimed at strengthening current DNA effectiveness. These include clarifying responsibilities of key individuals, sharpening reporting channels and oversight responsibilities, and modifying relevant DNA directives to reflect these changes. On the issue of whether the DNA Director should be military or civilian, however, the panel was divided. Cases for both are presented in the report. It is important to observe that DNA is, and has been, operating effectively across a wide range of national nuclear weapons, operational, and research missions.

**7245 (AD-A—171688/5/XAB) Geophysical plasmas and atmospheric modeling. Final report.** Hyman; Drake; Ganguli; Ganguli; Goodrich. (Science Applications International Corp., McLean, VA (USA)). Jul 1986. 722p. (SAIC—86/1781). NTISMF E04.

Availability: Microfiche copies only.

Contents include: magnetospheric physics: high-frequency waves; whistler growth in a cold-plasma injection experiment; collective particle-accelerator studies; magnetosphere-ionosphere coupling; high-latitude ionospheric investigations; plasma transport in the auroral return-current region; ion-cyclotron-wave turbulence in the auroral ionosphere; preferred scale size in the structuring of barium clouds; spectral characteristics of interchange turbulence in the ionosphere; debris air coupling in HANE and in the NRL laser experiment; power spectral density of radiating plasma clouds; debris charge states in HANE and in the NRL laser experiment; low frequency instabilities in HANE; numerical studies of the dynamics of the summer monsoon; and middle-atmosphere transport and chemistry studies.

**7246 (AD-A—171862/6/XAB) Normal D-region models for weapon-effects code. Technical report, 1 January-24 August 1985.** Gambill. (Kaman Tempo, Santa Barbara, CA (USA)). 18 Sep 1985. 66p. (KT—85-038(R)). NTIS, PC A04/MF A01.

This report examines several normal D-region models and their application to vlf/f propagation predictions. Special emphasis is placed on defining models that reproduce measured normal propagation data and also provide reasonable departure/recovery conditions after an ionospheric disturbance. An interim numerical model is described that provides for selection of a range of normal D-region electron profiles and also provides for a smooth transition to disturbed profiles. Requirements are also examined for defining prescribed D-region profiles using complex aero-chemistry models.

**7247 (AD-A—995289/6/XAB) Operation Sun Beam, Shot Little Feller II. Project Officers report. Project 1.5. Debris throwout.** Kruchko, G.L. (Army Engineer Research and Development Labs., Fort Belvoir, VA (USA)). 1 Apr 1985. 55p. NTIS, PC A04/MF A01.

To assess the significance of surface missiles as a casualty-producing source from very low-yield, near-surface, nuclear bursts was the primary objective of this experiment. Test objects which consisted of cylinders, cubes, plates, and various building materials were placed in a pattern around ground zero and, by locating these objects and determining reactions and displacements, the significance of this hazard was evaluated. This was the first experiment of this type to investigate solely blast-driven surface debris. Results showed that 20% of the test objects were displaced a distance of 300 feet or more from ground zero. The maximum displacement was 711 feet. In addition to the objects, tree branches were placed at varying heights above the ground surface and at varying distances out to 200 feet from ground zero. Large poles were used to hold the branches perpendicular to radial lines extending out from ground zero. The maximum branch displacement was 420 feet from ground zero, and 20% of all branches were displaced over 260 feet from ground zero.

**7248 (AD-A—995360/5/XAB) Operation Sun Beam, Shot Small Boy. Project Officers report. Project 1.4. Shock photography.** Hanlon, P.; Dieter, C.F. (Naval Ordnance Lab., White Oak, MD (USA)). 1 Sep 1985. 29p. NTIS, PC A03/MF A01.

The objective of this project was to measure the shock position as a function of time from which shock velocities and pressures in limited regions could be calculated, and any asymmetric growth both along along and above the surface could be detected. An outgrowth of the fireball along the surface was observed, and it was attributed to surface heating. The rate of growth along the surface was asymmetric. The growth along the 113 deg azimuth was markedly greater than in any of the other directions measured. Contrary to previous experience with surface shots, the peak pressures obtained above ground zero were less than those obtained along the surface at the same distances. there is some evidence to suggest that the focusing noted on previous shots did not occur or was very much reduced. Scaled Small Boy peak pressure-distance data are in agreement with the composite surface-burst pressure-distance curve.

**7249 (AD-A—995361/3/XAB) Operation Sun Beam, Shot Small Boy. Project Officers report. Project 1.9. Crater measurements.** Rooke, A.D.; Davis, L.K.; Strange, J.N. (Army Engineer Waterways Experiment Station, Vicksburg, MS (USA)). 1 Sep 1985. 72p. NTIS, PC A04/MF A01.

The objectives of Project 1.9 were to obtain the dimensions of the apparent and true craters formed by the Small Boy event and to measure the permanent earth deformation occurring beyond the true crater boundary. Measurements were made of the apparent crater by aerial stereophotography and ground survey and of the true crater and subsurface zones of residual deformation by the excavation and mapping of an array of vertical, colored sand columns which were placed along one crater diameter prior to the shot. The results of the crater exploration are discussed, particularly the permanent compression of the medium beneath the true crater which was responsible for the major portion of the apparent and true crater volumes. Apparent and true crater dimensions are compared with those of previous cratering events.

**7250 (AD-A—995368/8/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 1.1. Nuclear airblast phenomena.** Keefer, J.H.; Reisler, R.E.; Schwartz, E.G. (Army Armament Research and Development Command, Aberdeen Proving Ground, MD (USA). Ballistics Research Lab.). 1 Sep 1985. 141p. NTIS, PC A07/MF A01.

The objectives of this project were to: (1) measure airblast phenomena in the high-, moderate-, and low-pressure regions along a blast line; (2) integrated new data with existing nuclear-blast information; and (3) evaluate new types of pressure transducers and recorders for use on nuclear tests. Information which was obtained is contained in the form of tables and graphs. A tabulation indicating success of the instrumentation and a discussion of anomalies is presented.

**7251 (AD-A—995369/6/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 1.2. Close-in earth motion.** Swift, L.M.; Eisler, J.D. (Stanford Research Inst., Menlo Park, CA (USA)). 1 Sep 1985. 67p. NTIS, PC A04/MF A01.

Objectives of this project were: (1) to measure the airblast-induced motion from a surface nuclear burst as a function of depth and ground range, with emphasis on the high over-pressure region and particularly at ground zero; (2) to study the data and compare the results with those obtained on shots of other configurations for the eventual purpose of improving the available prediction procedures used as criteria for protective construction; and (3) to provide input data to the structures projects taking part in this operation.

7252 **(AD-A—995370/4/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 1.3. Underground stress measurements.** Bulin, G.V.; Auld, H.E.; Obenchain, R.; Arentz, A.; Wilson, S.D. (Air Force Weapons Lab., Kirtland AFB, NM (USA)). 1 Sep 1985. 106p. NTIS, PC A06/MF A01.

Project 1.3 attempted to measure dynamic stress and strain induced in the earth by the passage of an airblast wave over the surface with the aid of a newly developed stress gage. An array of omnidirectional velocity-sensitive switches was also include in an attempt to distinguish between, and measure, the propagation velocities of the peak compression and shear stress fronts induced by the airblast in the earth. Due to radiation effects produced by the detonation, the stress gages failed to give any usable stress or strain data. The time-of-arrival switch array performed satisfactorily, and compressional wave velocity data is presented together with calculations of constrained modulus for Frenchman Flat soil. Flexible casing was also installed at several ranges close to ground zero for measurement of permanent ground deformation. Data on perr`anent horizontal and vertical movement with depth is presented.

7253 **(AD-A—995371/2/XAB) Operation Sun Beam, Shots Little Feller I and II. Project Officer's report - Project 1.9. Crater size and shape.** Rooke, A.D.; Strange, J.N. (Army Engineer Waterways Experiment Station, Vicksburg, MS (USA)). 1 Sep 1985. 49p. NTIS, PC A03/MF A01.

Objectives of Project 1.9 were to obtain the dimensions of the apparent and true craters formed in desert alluvium by the Little Feller II event, a low airburst, and to measure the permanent earth deformation occurring within the plastic response zone. A later requirement was the measurement of the apparent crater formed by Little Feller I, fired ten days after Little Feller II. The Little Feller II experiment used colored sand columns, vertically embedded in the vicinity of ground zero, to enable postshot measurement of permanent earth deformation below the apparent crater. In this report, postshot excavation and mapping of these columns is discussed, the results are evaluated, and correlation is made with previous cratering data.

7254 **(AD-A—995372/0/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 2.2. Measurement of fast-neutron dose rate as a function of time.** Kronenberg; Markow; Balton, I.A. (Army Electronics Labs., Fort Monmouth, NJ (USA)). 1 Sep 1985. 79p. NTIS, PC A05/MF A01.

The dose rates of fast neutrons as a function of time were obtained. In view of the fact that the measurement of the neutron spectrum as a function of time was only an attempt and was instrumented very marginally, the objective of the experiment was achieved. However, because of the paucity of data points, the information was marginal and was obtained only because of multiple duplication at each station. The detectors worked well in all cases where they were not damaged by rough handling. The biggest drawback in the experiment was difficulty with electronic equipment, in particular with the amplifiers that had to be designed and built in the laboratory within a very limited time. The reliability of the recorded data was good, and it was concluded that effects other than radiation did not influence th sensor outputs.

7255 **(AD-A—995373/8/XAB) Operation Sun Beam, Shots Little Feller II and Johnie Boy. Project Officer's report - Project 2.16. Residual radiation in the crater and crater-lip area of low-yield nuclear devices.** Morris, P.J.; Carey, H.R.; Hofmann, F.L. (Army Engineer Research and Development Labs., Fort Belvoir, VA (USA)). 1 Sep 1985. 66p. NTIS, PC A04/MF A01.

The objective of this project was to obtain information about the residual radiation environment in the crater and crater-lip area resulting from the employment of low-yield fission weapons. The information needed specifically was (1) the change in intensity with time; (2) the change in mean-gamma-energy level with time; and (3) the activity-level variation with depth in the soil.

7256 **(AD-A—995374/6/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 3.3. Behavior of buried model-arch structures.** Swalley, R.F. (Naval Civil Engineering Lab., Port Hueneme, CA (USA)). 1 Sep 1985. 117p. NTIS, PC A06/MF A01.

Six small buried arches were subjected to blast loads from a nuclear explosion to provide information on their structural behavior. The principal objectives were to determine the effect of a traveling blast wave on arch response and to check model scaling relationships. It was determined that the traveling wave caused arch response in the first antisymmetrical mode, which was superposed on response in a symmetrical mode. The relative importance of the response in the antisymmetrical mode was not determined. The scaling relationship for overpressure was found to be unity. Information on thrusts, moments, accelerations, pressures, deflections, and arching is also presented.

7257 **(AD-A—995375/3/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 3.4. Structures instrumentation.** Schwartz, E.C.; Reisler, R.E.; Keefer, J.H. (Army Armament Research and Development Command, Aberdeen Proving Ground, MD (USA). Ballistics Research Lab.). 1 Sep 1985. 105p. NTIS, PC A06/MF A01.

This report discusses the measurement techniques and procedures used by BRL to obtain the loading and response data from structural designs of several agencies on Operation Sun Beam. Project objectives were: (1) to provide supporting instrumentation for pressure versus time, acceleration versus time, displacement versus time, stress versus time, and deflection versus time measurements for structures projects; and (2) to obtain data on air blast or ground shock required to properly analyze the results of the structures projects. The instrumentation used to obtain data in support of the requesting agencies was adequate to accomplish the objective. Modifications to the instrumentation procedure to gain improved results are desired.

7258 **(AD-A—995376/1/XAB) Operation Sun Beam, Shot Small Boy. Project Officers report - Project 6.4. Measurement of gamma dose rate as a function of time.** Kronenberg; Markow; Balton, I.A. (Army Electronics Labs., Fort Monmouth, NJ (USA)). 1 Sep 1985. 75p. NTIS, PC A04/MF A01.

The primary objective of this project was to obtain measurements of gamma rate as a function of distance and time for evaluation of the electromagnetic (EM) effect. The secondary objective was to measure the gamma rate as a function of distance without involving the EM effect. Such data are of interest in connection with transient radiation effects on electronic components. A newly developed gamma detector, called SEMIRAD, was used. The reason for choosing this device rather than other conventional gamma detectors is its extremely rapid time response, limited only the collection time of the secondary electrons, and its high dose-rate saturation limit. Results of the gamma-dose-rate measurement as a function of time are fragmentary and represent an undistorted measurement in only a few intervals. Failures of equipment and/or human factors accounted for missing data. The data could be improved in future experiments if changes are made in the instrumentation, i.e., better EM shielding, improved tape recorders and generally higher quality electronics.

7259 **(AD-A—995377/9/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 6.9. Correlation of present and previous electric-field measurements.** Reno; Fowles, H.M. (Denver Research Inst., CO (USA). Electronics Div.). 1 Sep 1985. 13p. NTIS, PC A02/MF A01.

On most previous nuclear detonations, signatures and quantitative measurements of the electric-field signals associated with the detonations was obtained at distances such that normal radiation field characteristics apply. On Small Boy, measurements were made from stations located much closer in, such as to be inside, on the boundary of and just outside the limits of the ionized sphere created by the nuclear burst. The electric-field characteristics in these regions were unknown. In the hope of providing continuity from the region of the unknown into the reasonably well-understood

region of the radiation field, this project was requested to make the typical radiation-field type of measurement that had been made on previous detonations. This report covers the signature characteristics and quantitative measurements of the electric-field signal from Small Boy as seen from outside the immediate region of theoretical generating mechanism.

7260 **(AD-A—995378/7/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 7.1.4. Transient radiation effects measurements on guidance-system circuits.** Sykes, P.J. (Air Force Special Weapons Center, Kirtland AFB, NM (USA)). 1 Sep 1985. 116p. NTIS, PC A06/MF A01.

This project was conducted to obtain data on the transient response of typical ballistic-missile guidance and control systems to the prompt gamma pulse from a nuclear weapon. Self-reading instrumentation was installed at four stations corresponding to four decads of gamma radiation intensity to determine whether the output transients in these circuits exceeded present threshold levels during the test. Additional diagnostic instrumentation was provided at one location to obtain pulse shape information on the circuits, gamma dose rate time history, and analog data on circuits which exhibited long recovery times. Extensive pre- and post-shot laboratory experiments were performed to determine response in an actual weapon environment. Results indicated that field test data are consistent with the combined experimental and theoretical predictions.

7261 **(AD-A—995379/5/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 7.8. Arming and fuzing component test.** Taslitt, N. (Naval Ordnance Lab., White Oak, MD (USA)). 1 Sep 1985. 13p. NTIS, PC A02/MF A01.

The objectives of this project were to (1) determine whether the radiation from a nuclear weapon can disable various arming and fuzing components by causing permanent damage; (2) determine whether transient nuclear radiation can induce an operating fuze to malfunction; and (3) compare nuclear weapon radiation effects with those produced by various radiation simulators. Data obtained revealed that none of the inertial components were detrimentally affected. The electronic components were severely degraded but would have satisfactorily accomplished their tactical functions. No electromagnetic effects were detected.

7262 **(AD-A—995380/3/XAB) Operation Sun Beam, Shots Little Feller II and Small Boy. Project Officer's report - Project 7.16. Airborne E-field radiation measurements of electromagnetic-pulse phenomena.** Butler, K.L. (Naval Missile Center, Point Mugu, CA (USA)). 1 Sep 1985. 33p. NTIS, PC A03/MF A01.

Airborne measurements of the absolute vertical electric field (E-field) of the radiated electromagnetic pulse were attempted for Shots Little Feller II and Small Boy. Instrumentation included calibrated vertical whip antennas, wideband magnetic tape recorders, and photographs of oscilloscope traces. One instrumented aircraft participated in Little Feller II (C-131F); two aircraft participated in Small Boy (a C-131F and an A-3A). No detectable signals were recorded for either event. It is concluded that the vertical E-field intensities encountered were below the calibrated levels of the instrumentation or the method of instrumentation and calibration was inadequate for nonrepetitive pulse signals.

7263 **(AD-A—995410/8/XAB) Operation Sun Beam, Shot Small Boy. Project Officer's report - Project 7.10. Spectral analysis with high-time resolution of the thermal-radiation pulse.** Mahoney, J.J.; Harris, L.H.; Hennecke, H.J.; Claflin, A.B.; Fekete, M.W. (Army Nuclear Effects Lab., Edgewood Arsenal, MD (USA)). 1 Sep 1985. 65p. NTIS, PC A04/MF A01.

The primary objective of this project was to investigate the spectral irradiance and luminosity versus time for the first thermal pulse at Shot Small Boy. This was accomplished by use of spectral filters with narrow band passes, phototubes, and magnetic tape recorders with high time resolution at two locations. The measured elapsed time to the first thermal maximum was from 50 to 110 microseconds, depending on wavelength. A graph of radiant thermal power versus time was obtained for the thermal pulse. The delineation of the first thermal pulse, especially the rise portion, is considered to be more definite than has been obtained previously. The resolution time of the instrumentation was approximately 50 microseconds. Secondary objectives were to measure the total luminosity versus time and also to measure the atmospheric attenuation. These objectives were accomplished by making measurements at two distances, 2.5 and 3.5 miles, from ground zero. In the case of the total luminosity measurements, a system of filters with a spectral transmittance approximating the sensitivity response of the average human eye was used. The results are tabulated in the report.

7264 **(AD-A—995447/0/XAB) Operation Greenhouse. Scientific Director's report of atomic-weapon tests at Eniwetok, 1951. Annex 1.2. Delayed gamma-ray measurements. Part 1. Gamma-ray spectrum measurements (abridged).** Gibson, H.F.; Miller; Motz, J.W.; Smeltzer, J.C.; Wyckoff, H.O. (National Bureau of Standards, Washington, DC (USA). Radiation Physics Div.). 1 Sep 1985. 59p. NTIS, PC A04/MF A01.

Extracted version of report dated Apr 52. See also Annex 1.2, Part 4, AD-A995 420; Availability: Microfiche copies only.

Measurements of bomb efficiencies from the number of gamma rays requires fundamentally two separate experiments. The average number of gamma rays emitted from the fission fragments (delayed gamma rays) per fission must be determined. This experiment can be carried out in the laboratory. A second experiment, the absolute determination of the number of gamma rays from the bomb was also attempted. Because gamma rays are not directly observable but are measurable only through their secondary effects, and because the probability of occurrence of the secondary effects depends upon the gamma ray energy, it is not usually possible to count directly the number of gamma rays in a heterochromatic spectrum. A spectral distribution must be first obtained from which the actual total number of gamma rays may be computed. This volume discusses, in detail, the planning for the experiment and the spectral distribution of collimated gamma-rays determined from the Greenhouse tests on two shots. A discussion of measurement of build-up factor which is needed to estimate the effect of collimation is also given.

7265 **(AD-A—995448/8/XAB) Operation Ivy. Project 7.5. Dispersion of gaseous debris from nuclear explosions.** Allen, P.W. (Department of the Air Force, Washington, DC (USA)). 1 Sep 1985. 26p. NTIS, PC A03/MF A01.

This project was designed to provide information for the solution of two problems: (1) dispersion of gaseous debris; and (2) initial cloud dimensions. Observations indicated that the major portion of the Mike cloud entered the stratosphere - the cloud top reached 120,000 feet with the mushroom base at about 67,000 feet. The tropopause height at the time of the detonation was about 58,000 feet. The top of the King cloud reached about 74,000 feet with the mushroom base at about 40,000 feet. Samples for the measurement of the world-wide distribution of induced gaseous activity (tritium and carbon-14) were taken at widely separated geographical positions, including both northern and southern hemisphere points. These samples were periodically collected at each location over a period of six months following the detonations.

7266 **(AD-A—995449/6/XAB) Operation Sun Beam, Shots Little Feller I, II and Johnie Boy. Project officers report. Project 6.6. Electromagnetic measurements.** Henderson, W.D.; Livingston, P.M.; Rutter, R.L. (Air Force Special Weapons Center, Kirtland AFB, NM (USA)). 1 Sep 1985. 86p. NTIS, PC A05/MF A01.

Extracted version of report; Availability: Microfiche copies only.

Of considerable interest from both a physical and practical viewpoint is the coupling of electromagnetic energy from a nuclear explosion into various electrical systems in the vicinity of the burst. A series of electromagnetic measurements were made on Shots Little Feller I, Little Feller II, and Johnie Boy. It is clear from the records that radiation shielding must be given closer consideration in future tests. Due to equipment failure and radiation inactivation, only the Johnie Boy dynamic current measurement and the passive peak current indicators on all three events are interpretable.

7267 **Measurements and calculations of shock propagation in dry desert alluvium.** Bass, R.C. (Sandia National Labs., Albuquerque, NM). pp 633-637 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper discusses a recent underground nuclear detonation in alluvium that utilized a large diameter device emplacement hole and the entire instrumentation array was installed in the backfill material. No significant spall or surface reflections were noted in the data obtained in this large cased hole and the shock structure was clearly detailed to locations close to the surface. Several smaller conventional high explosive detonations located closer to the surface have also been studied in detail. In these instances several satellite instrumentation holes were available and measurements were made at or near the detonation horizon minimizing surface effects. Data from two explosive detonations and the data from the nuclear detonation are compared with computer code calculations made to describe underground explosions in alluvium. Supportive data from a plane wave surface detonation are also discussed.

### 4503 Explosion Detection

7268 **(AD-A—171744/6/XAB) Evaluation of the performance during the gse technical test. Technical report, 1 January-30 June 1986.** Campanella, A.; Israelsson, H.; Jurkevics, A.; Dysart, P.; Pullin, J. (Science Applications International Corp., Arlington, VA (USA)). Jul 1986. 139p. (SAIC—86/1114). NTIS, PC A07/MF A01.

Continuing evaluations of the Center's performance during the GSE Technical Test led to improvements in the automatic association program and verified that the automatic signal detector flagged all expected seismic P-waves. Research on methods for the analysis of seismic data resulted in demonstration of promising methods for identifying pp by polarization filtering and a correlation method. Polarization filtering was applied to two events near the Aral Sea and helped determine that complications in the signals at NORESS were not due to a multiple explosive source. Another investigation of regional events recorded at NORESS revealed spectral differences that could be used to discriminate between earthquakes and explosions in a limited source region. Network capability studies demonstrated agreement between SNAP/D estimates and results from a network in the Baikal region, as well as possible effects of source radiation patterns on station detection thresholds. Analysis of explosion generated and synthetic waveforms showed that waveform periods and shapes can be used to constrain estimates of $t^*$, and illustrated the strong dependence of $t^*$ estimates on assumptions about near-source conditions.

7269 **(UCID—20853) Decision analysis framework for evaluating CTBT seismic verification options.** Judd, B.R.; Strait, R.S.; Younker, L.W. (Lawrence Livermore National Lab., CA (USA)). Sep 1986. Contract W-7405-ENG-48. 45p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002369.

This report describes a decision analysis framework for evaluating seismic verification options for a Comprehensive Test Ban Treaty (CTBT). In addition to providing policy makers with insights into the relative merits of different options, the framework is intended to assist in formulating and evaluating political decisions - such as responses to evidence of violations - and in setting research priorities related to the options. To provide these broad analytical capabilities to decision makers, the framework incorporates a wide variety of issues. These include seismic monitoring capabilities, evasion possibilities, evidence produced by seismic systems, US response to the evidence, the dependence between US and Soviet decision-making, and the relative values of possible outcomes to the US and the Soviet Union. An added benefit of the framework is its potential use to improve communication about these CTBT verification issues among US experts and decision makers. The framework has been implemented on a portable microcomputer to facilitate this communication through demonstration and rapid evaluation of alternative judgments and policy choices. The report presents the framework and its application in four parts. The first part describes the decision analysis framework and the types of analytical results produced. In the second part, the framework is used to evaluate representative seismic verification options. The third part describes the results of sensitivity analyses that determine the relative importance of the uncertainties or subjective judgments that influence the evaluation of the options. The fourth (and final) part summaries conclusions and presents implications of the sample analytical results for further research and for policy-making related to CTBT verification. The fourth section also describes the next steps in the development and use of the decision analysis framework.

## 50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

### 5001 Basic Studies

7270 **(MAP-HANDBK—8) Middle Atmosphere Program. Handbook for MAP. Volume 18: Extended abstracts.** Kato, S. (International Council of Scientific Unions). Dec 1985. 536p. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Various topics related to middle atmosphere research are discussed. Variability of the middle atmosphere during winter, climatology, gravity waves, atmospheric turbulence, transport processes of trace species and aerosols, and research in the Antarctic are among the topics covered.

7271 (MAP-HANDBK—8, pp vp) **Exicimer lidar measurements of ozone.** Shibata, T.; Uchino, O.; Maeda, M. (Meteorological Research Inst., Tsukuba (Japan). Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

The observation of the atmospheric ozone profile in an altitude range of 3 to 28 km by means of differential absorption lidar in combination with an XeCl laser (308 nm) and SRS pumped by a KrF laser (249 nm) is discussed.

7272 (MAP-HANDBK—8, pp vp) **Lidar observations of the nighttime sodium layer at 33 deg N.** Uchiumi, M.; Hirono, M.; Fujiwara, M. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Measurements of the nighttime atmospheric sodium layer have been performed since 1977, using a dye lidar at Fukuoka (33.4 deg N, 130.2 deg E.). The Kyushu lidar uses a flashlamp pumped dye laser tuned to the sodium D sub 2 line (589.0 nm) as a transmitter. The dye laser used in the Kyushu lidar system has been described elsewhere. Sporadic enhancements of the total column abundance of the layer during the Perseids meteor shower were observed on the nights of August 12 and 13, 1978, 1979, 1981, and 1983. Degrading weather conditions prevented observation on the nights during 1980 and 1983. A contour plot of the sodium layer for the period of 8 hours from 21:00 to 5:00 JST on the night of August 12 to 13 1983, is shown. The predominant feature visible is the increase in the height of peak density from 21:00 to 2:00 JST, and the slight decrease in the height of peak density from 2:00 to 5:00 JST. The average abundance had a maximum of about 7 x 10 to the 13th power/sq m on August 13. A plot is presented of the nightly average abundance for available data. The sodium layer abundance increased on the night of August 12 to 13, 1983, during the peak of the Perseids meteor shower, and the following night, August 13 to 14, almost went back to the monthly mean.

7273 (MAP-HANDBK—8, pp vp) **Special ozone observation at Syowa Station, Antarctica from February 1982 to January 1983.** Chubachi, S. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

The behavior of stratospheric ozone at high latitudes is especially interesting, since the stratospheric ozone at high latitudes is thought to be transported from low latitudes through dynamical processes. However, only limited information has so far been obtained, because ozone observations at high latitudes are sparse. There are only two ozone observation stations operating in Antarctica: Syowa Station and Amundsen-Scott, where the total ozone has been observed in sunlit months only. To make up for this deficiency, extensive observations were carried out at Syowa Station as part of MAP. Some preliminary results of these observations are described.

7274 (MAP-HANDBK—8, pp vp) **Observation of atmospheric minor constituents by FTIR at Syowa Station, Antarctica.** Makino, Y.; Muramatsu, H.; Kawaguchi, S.; Yamanouchi, T.; Tanaka, M.; Ogawa, T. (National Institute of Polar Research, Tokyo, Japan; Tohoku Univ., Sendai, Japan; Tokyo Univ., Japan). Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

As a part of the Antarctic MAP activity, a ground-based spectroscopic observation of atmospheric infrared transmission was started at Syowa station (69 deg 00'S, 39 deg 35'E) in March 24, 1983. Observations of sunlight as a radiation source were made with a Fourier transform infrared spectrometer having a maximum path difference of 80 mm and an apodized FWHM resolution of approx. 0.12/cm. In routine operation through the year, the resolution of approx. 0.8/cm was applied for economy of data-processing time. The 408 spectra for 72 days were obtained in about 10 months until January 23, 1984. From the absorption features revealed in the spectra over the wave number range of 500 to 7500/cm, a preliminary estimate of N202 gamma sub 1 band absorption was attempted. An apparent transmittance was defined at the wave number 2576/cm, where the absorption by N20 molecules affected the observed intensity strongly. A ray-tracing technique and a line-by-line calculation with a model atmosphere and the AFGL atmospheric absorption line parameters compilation were applied to the calculation of the synthetic spectra.

7275 (MAP-HANDBK—8, pp vp) **Measurement of polar stratospheric NO2 from the 23rd and 24th Japanese Antarctic Research Expedition (JARE) balloon experiments.** Shibasaki, K.; Iwagami, N.; Ogawa, T. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

As a part of the Japanese activities of MAP in the Antarctica, balloon-borne measurements of the stratospheric NO2 profile were planned and carried out by the JARE 23rd and 24th wintering parties. Few results have been reported so far as the stratospheric NO2 profile at high latitude. There were no reported balloon measurements carried out in the Southern Hemisphere. Profiles are presented for the first balloon-borne measurement of the stratospheric NO2 in the Antarctica. Three balloons named JA21, JA25 and JA26 were launched from Syowa Station (69 deg S, 35.6 deg E) using 5000 cu. cm plastic balloons. JA21 balloon was launched on November 24, 1982, and JA25 and JA26 balloons on November 12 and 20, 1983, respectively.

7276 (MAP-HANDBK—8, pp vp) **Decomposition of CO2 molecules due to auroral X-rays.** Sekihara, K. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

It has been reported by SEKIHARA (1981), that the circumpolar measurement from a commercial airliner reported by PRATT and FALCONER (1979) was subjected to a strong influence of a geomagnetic storm, specifically at the beginning stage through the North Pole. The main point of interest was the increase of CO concentration by the order of 10 ppb that took place simultaneously with a temperature decrease of several degrees, which was regarded as a result of enhanced cooling to space due to CO2 decomposition. Later inspection of the original magnetogram of eleven auroral zone stations revealed that the observation started 13 hours after the main phase of a geomagnetic storm, which lasted for 22 hours. A quantitative estimation is made of CO2 decomposition due to auroral X-rays that should take place during the degradation of photoelectrons injected into the lower stratospheres.

7277 (MAP-HANDBK—8, pp vp) **Balloon-borne observation of Aitken nuclei in the Antarctic stratosphere and troposphere.** Ito, T.; Ikegami, M.; Kanazawa, I.; Iwasaka, Y. (Nagoya Univ., Japan). Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Aitken nuclei (0.002 or = r or = 0.1 microns in the atmosphere are produced through gas-to-particle conversion processes, and they grow in size by heterogeneous nucleation processes and others to produce larger aerosol particles. In the study of global background aerosol pollution, full knowledge of such aerosol processes in the clean atmosphere is essentially required. In this sense, it is important to examine the behavior of aerosols in a clean atmosphere which is not contaminated directly by aerosols and gases emitted from the Earth's surface. The Antarctic atmosphere is thought to be such a clean atmosphere. From an extensive surface observation of aerosols carried out at Syowa Station (69 deg 00'S, 39 deg 35'E) Antarctica, it has been revealed that various phenomena relating to long-range transport of trace constituents and/or photochemical processes resulting in production or growth of aerosol particles are clearly observed in Antarctica. This paper gives a preliminary report of observations made by balloon-borne Aitken nuclei sonde in 1983, at Syowa Station.

7278 (MAP-HANDBK—8, pp vp) **Seasonal and diurnal variation of the atmospheric NO2 at Syowa Station, Antarctica.** Shibasaki, K. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Extensive attention has been directed to nitrogen dioxide (NO2) since its important role in the atmospheric chemistry relating to the stratospheric ozone (e.g., WMO, 1982) has been pointed out. However, the behavior of NO2 in the atmosphere has still not been fully confirmed, although ground-based, balloon and satellite measurements of NO2 have been reported by many scientists. Especially, only a few measurements made at high latitude in the Southern Hemisphere have been reported. The total atmospheric NO2 by ground-based visible absorption spectroscopy at Syowa Station (69 deg S, 39.6 deg E), Antarctica. The observation continued from March 1983, to January 1984. The principles of measurement, instrumentation and the method of data analysis are described in detail.

## 5002 Chemicals Monitoring And Transport

*REFER ALSO TO CITATION(S) 6461, 6462, 6484, 6489, 6490, 6626, 6765, 6766, 7031, 7428, 7486, 7487*

7279 (AD-A—171482/3/XAB) **Polynuclear aromatic hydrocarbons (PAH). Final report.** Poitrast, B.J. (Air Force Occupational and Environmental Health Lab., Brooks AFB, TX (USA)). Jul 1986. 10p. (OEHL—86-054C00253GCE). NTIS, PC A02/MF A01.

The purpose of this report is to discuss the hazard presented by polynuclear aromatic hydrocarbons (PAH) in soil and the workplace, to describe the requirements for soil treatment for these compounds, and to discuss potential occupational exposures which should be avoided. This report will present basic information on the history of these compounds, their toxicity, work sites effected in the Air Force, and discuss some alternatives to disposal through removal to a land site.

7280 (AD-A—171838/6/XAB) **Effects of atmospheric contaminants under hyperbaric conditions with particular reference to vision. Interim report.** Luria, S.M. (Naval Submarine Medical Research Lab., Groton, CT (USA)). 13 Aug 1986. 18p. (NSMRL-MR—86-5). NTIS, PC A02/MF A01.

A literature search was carried out for studies investigating the effects, particularly on vision, of atmospheric contaminants

under pressure. Little is known of the effects on vision of most contaminants under any pressure. What is known of the effects of oxygen, nitrogen, carbon dioxide and monoxide, ozone, organic vapors, trace metals, and a refrigerant are presented.

7281 (LBL—20261, pp 4-6) **Organic compounds and organic reactions in precipitation.** Graedel, T.E. (AT and T Bell Labs., Murray Hill, NJ). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Organic compounds in precipitation may exist in any of several forms. They are: water soluble compounds; relatively insoluble compounds; complexes; and, chelates. Organic chemistry in precipitation involves many facets of organic chemistry. The details of organic processes and their relationship to precipitation chemistry is relatively unexplored, and remain a challenge for the atmospheric chemist.

7282 (LBL—20261, pp 7-9) **Organic oxysulfur compounds from $SO_2$ chemistry in the atmosphere.** Eatough, D.J.; Hansen, L.D. (Brigham Young Univ., Provo, UT). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The reaction of $SO_2$ (g) with organic compounds in the atmosphere results in the formation of a variety of gas phase and aerosol organic compounds. The following compounds have been identified as major products of atmospheric chemistry: Bis-Hydroxymethyl Sulfone, and Hydroxymethane Sulfonic Acid. None of these compounds are found in appreciable concentrations in emission from sources of $SO_2$(g) but each are formed in the atmosphere as secondary products of $SO_2$ (g) chemistry.

7283 (LBL—20261, pp 12-14) **Nucleation and aerosol formation in reactive systems.** Keesee, R.G.; Breen, J.J.; Kilgore, K.; DiFazio, L.; Leuchtner, R.E.; Castleman, A.W. Jr. (Pennsylvania State Univ., University Park). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Despite their potential importance to the chemistry troposphere, and especially source dominated atmospheres, little is known about the details of the transfer of molecules from the gaseous to the condensed state by either new particle formation or heterogeneous processes including adsorption onto or dissolution into aerosol particles. It is becoming well recognized that research on clusters provides a valuable approach in understanding gas-to-particle conversion and the role of small particles in the chemistry of the atmosphere. Clusters can be produced by supersonic expansion of a gas through a nozzle into vacuum. In the authors laboratory, the authors have developed a co-expanding nozzle source as a method for producing clusters consisting of reactive species. In view of their atmospheric importance and potential role in particle formation, $SO_3$ and $NH_3$ are an interesting pair of gases for study. When a few torr of each gas are mixed, a solid material is produced. A yellow solid which has a stoichiometric ratio of 1:2 and a white solid with a 2:1 ratio for $NH_3$ to $SO_2$ have been identified. Both of these solids reversibly sublime back to $NH_3$ and $SO_3$ as the pressure of the gas phase is reduced. Decomposition is through to lead to the other observed colors. The authors performed a series of experiments in which ammonia was expanded from the inner nozzle and $SO_2$ introduced through the annular opening and another series in which the roles of the gases were reversed.

7284 (LBL—20261, pp 15) **Catalytic oxidation of sulfur dioxide in aerosol particles.** Jones, C.L.; Flagan, R.C.; Seinfeld, J.H. (California Institute of Technology, Pasadena). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The oxidation of sulfur dioxide in liquid aerosol particles containing manganese is currently being studied using a continuous-stirred tank reactor (tau ~ 1 hr). High humidity, greater than 85%, is maintained to simulate conditions that might be found in stack gases. Previous studies of aerosol growth under such conditions have been plagued by the problems generated by the humid conditions, particularly that of the aerosol size measurement. Specifically, care must be taken so that the sample humidity is not altered by the instrument, thus biasing the size measurements. The authors are using a mobility classifier-condensation nuclei counter combination to determine the feed and effluent aerosol size distribution. Growth occurs as a result of the change in particle water activity due to the ionic strength change caused by the reaction of S(IV) to S(VI). From the change in the size distributions, the relative importance of heterogeneous oxidation can be inferred. The experiments, therefore, provide an integrated assessment of the reaction kinetics/thermodynamic coupling that exists in aerosols growing as a result of chemical reaction. In addition, the aerosol growth can be predicted by extrapolating the results of available bulk phase laboratory studies and compared with that measured experimentally.

7285 (LBL—20261, pp 16) **Adsorption of gases at evaporating and condensing water surfaces.** Matteson, M.J.; Schirmer, W. III. (Georgia Institute of Technology, Atlanta). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Single water droplets, 0.23 cm in diameter were suspended and allowed to evaporate, partially in a nitrogen stream (50 cm/sec) containing various concentrations of $SO_2$ ($1\text{-}3 \times 10^{-3}$ atm) and water vapor (6.8-16.9 mm Hg). In a separate series of tests, the $SO_2$ was replaced by $O_2$ in the 21-80% range. The droplets were exposed for fixed time intervals, and then removed and analyzed for total sulfur oxide or $O_2$ content. The temperature of the droplet was monitored during the exposure time. Water vapor concentration in the bulk gas phase as well as $SO_2/O_2$ concentration determined the equilibrium saturation concentration of gas transferred to the water which was always less than that at thermal equilibrium. The rate of mass transfer was controlled by heat transfer to the droplets. In the second part of this study, water vapor in various concentrations was passed through a tubular furnace and condensed at various temperature (0-27°C) to form a cloud in the presence of $SO_2$ ($10^{-5}$-$10^{-3}$ atm). The condensed droplets were in the range of 1-2 μm. Cloud droplets were separated from the gas stream electrostatically and analyzed for sulfur content. Concentrations of $SO_2$ in the aqueous phase were supersaturated compared to those at equilibrium, were relatively independent of gas phase concentrations at y/sub $SO_2$/ $< 10^{-3}$ atm, and strongly dependent on the amount of water condensed. A mechanism is proposed whereby hydrate formation at the water surface explains the results observed.

7286 (LBL—20261, pp 17-19) **Accommodation coefficient measurements for ozone on water surfaces.** Lee, J.H.; Tang, I.N. (Brookhaven National Lab., Upton, NY). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Mass transfer is an important consideration in many dynamic processes that take place in both scientific studies and engineering applications. In particular, the rate of trace gas incorporation into aqueous droplets in the atmosphere has recently received much attention because of its relevance to acid precipitation. In the present paper, experimental results are reported on the interfacial mass transfer of gaseous ozone into aqueous phase: the accommodation coefficient for ozone has been measured for the first time. The experiments were carried out in the thermostated reaction cell, constructed of a rectangular Pyrex tube, 4 cm x 8 cm in cross section and 38 cm in length, and placed with its length in a horizontal position. The cell was equipped with an optical window on either end, gas inlet and outlet on the top, and liquid inlet and outlet on the bottom. Liquid water was circulated through the lower portion of the cell by an all-Teflon diaphragm pump, whereas trace quantities of ozone in a humidified carrier gas was flowing concurrently in the upper space. The system was designed to operate at low pressures, therefore, very delicate flow and pressure controls were essential in maintaining the required stability during an experiment.

7287 (LBL—20261, pp 20-22) **Flow reactor for the study of $SO_4$/sup =/ formation in simulated cloud water droplets.** Groblicki, P.J.; Ferman, M.A. (General Motors Research Labs., Warren, MI). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

An important source of atmospheric sulfates - a major constituent of acid deposition - is thought to be the oxidation of $SO_2$ in cloud water droplets. At the present time, popular methods for the study of sulfuric acid production in clouds include laboratory studies of bulk solution chemistry and in situ studies using aircraft or mountain-top sampling sites. This paper presents an intermediate approach, where a laboratory flow reactor is used to study chemical processes in well-controlled simulated clouds. A cloud is formed in the presence of typical atmospheric contaminants ($SO_2$, $H_2O_2$, $O_3$, $NO_2$, $NH_3$) at the top of a 4.5 m tube. Gaseous contaminant dissolution in the cloud droplets, followed by reaction in the droplets during the 4 minute residence time, leads to the production of sulfate in the droplets.

7288 (LBL—20261, pp 23-25) **$SO_2$ oxidation in cloud drops.** Miller, D.F.; Lamb, D.; Gertler, A.W. (Desert Research Institute, Reno, NV). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The prevalent mechanism of $SO_2$ oxidation in the atmosphere seems to vary with environmental conditions, as evidenced by the wide range of conversion rates reported for this pollutant. The results of numerous field studies indicate $SO_2$ oxidation rates on the order of 10% $h^{-1}$ even though it is estimated that the upper-limit rate for gas-phase oxidation by free radicals is < 3% $h^{-1}$. Alternative explanations for faster oxidation rates generally involve heterogeneous, two phase reactions which are not well characterized. Of interest here are the relatively large $SO_2$ conversion rates which have been observed in coastal environments. In this paper, the results of controlled cloud-chamber experiments with sea salt nuclei provide more direct evidence for a chemical effect attributed to such nuclei. Clouds were produced under constantly decreasing temperatures that forced the condensate of water vapor onto the CCN. Initial and final temperatures of the cloud were about 21 and 12°C respectively, over reaction periods of 400 to 600 s. The final liquid water content of the clouds ranged from 1 to 3 g $m^{-3}$, and median cloud drop diameters were approximately 10 μm. In the fully developed clouds, the salt concentrations were estimated to be 8 x $10^{-5}$ M and 5 x $10^{-3}$ M for the 0.1 and 0.4 μm CCN, respectively. SO> oxidation rates, expressed as % $h^{-1}$, are average rates based on the amount of aqueous sulfate produced over the period of cloud formation.

7289 (LBL—20261, pp 26-27) **Primary oxidants - results from field and laboratory experiments.** Benner, W.H.; Novakov, T. Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Combustion conditions for the burning of propane, butane, and natural gas were reported to influence $H_2O_2$ production by these flames. Following these findings, laboratory and field experiments were conducted to determine if a link exists between combustion emissions and heterogeneous oxidation of $SO_2$ in the atmosphere. A simple procedure was designed in which combustion products were sampled into aqueous solutions, and then the ratio of dissolved $SO_4$/sup =/ to [S(IV) + $SO_4$/sup =/] was determined by ion chromatography. The solutions were $H_2O$, 1 mM $H_2CO$ (pH = 5), 5 mM $CO_3$/sup =/ (pH = 10), a suspension of activated carbon, and a suspension of flame particles. The $H_2CO$ solution was used to quench the reactions between possible oxidants and S(IV) by converting the S(IV) to hydroxymethane sulfonate ion. The carbonate solution was used to quench the reaction between $H_2O_2$ and S(IV) by application of the fact that the rate constant for this reaction is $10^{-4}$ times slower at pH = 10 than at pH = 4. The solutions were analyzed for [$H_2O_2$] using a colorimetric technique.

7290 (LBL—20261, pp 28-30) **Role of surface oxygen in S(IV) oxidation in suspensions of various model black carbons.** Gundel, L.A.; Benner, W.H.; Novakov, T. Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Because of its potential significance for atmospheric chemistry, aqueous oxidation of sulfur dioxide by carbon particles has received considerable attention. However, there is significant disagreement about the importance of soot catalyzed $SO_2$ oxidation in the atmosphere. The principal reason for this disagreement is the extrapolation of laboratory studies, performed with different model carbons, to atmospheric conditions. Assessments of the importance of this process range from significant, under nonphotochemical conditions, to negligible. In this presentation, the authors give data on aqueous $SO_2$ oxidation by a number of commercial carbons as well as by ambient carbon particles. They also report investigations of the surface chemistry of these heterogeneous reactions, using evolved gas analysis (EGA), electron spectroscopy for chemical analysis (ESCA), and electron microscopy.

7291 (LBL—20261, pp 31-33) **Heterogeneous gas absorption by aerosol particles and droplets: a discussion of laboratory experiments.** Dlugi, R. (Kernforschungszentrum Karlsruhe GmbH, West Germany). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

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A considerable number of experiments on the $SO_2$ and NO/sub x/-absorption by aerosol particles and droplets give evidence that these processes can contribute to the formation of acids and salts in the atmosphere. The comparison of the experimental results show that especially due to catalysts or active surfaces the initial rates of these reactions can be in the order of 10 - $10^3$ % $H^{-1}$. But when the absorption/oxidation processes proceed, the rates of catalyzed or surface reactions decrease because the reaction limiting steps are influenced by the reaction products. Then the total removal of a gas by a certain mass of particles or droplets is limited for fixed thermodynamic conditions. A large number of experiments were performed in different chemical reactors to study the $SO_2$-NO/sub x/-$H_2O$-aerosol system. The main goals were to show the influence of different reactors and to determine empirical rate laws and the total removal of gases.

7292 (LBL—20261, pp 34) **Sensitivity analysis of the role of free radical, organic and transition metal reactions in sulfate production in clouds.** Cho, S.; Charmichael, G.R. (Univ. of Iowa, Iowa City). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The roles that in-cloud chemistry play in producing sulfate in cloudwater are evaluated in this paper by use of a flow-through chemical reactor model. In this paper, detailed gas and liquid phase chemical mechanisms are included in the analysis. The gas phase chemistry consists of some 80 reactions involving 40 chemical species. The liquid phase chemical mechanism has a similar number of species and includes hydrogen peroxide, organic peroxides (ROOH), formaldehyde, higher carbonyls (RCHO), formic acid, higher organic acids, (RCOOH), free radicals OH, $HO_2$, and $RO_2$, and transition metals. Model simulations of various initial conditions and cloud parameters are presented and discussed. Special attention is paid to the affect of organic species and transition metals on the sulfate production. The sensitivity of the model predictions to initial conditions and model parameters is evaluated. Local elementary sensitivity coefficients for various species important to sulfate production are presented and discussed. Further insights into the complex interactions between species are proceeded by the evaluation of the Green's functions for various model simulations. Finally, results of sulfate production in cumulus and orographic clouds obtained by detailed transport/chemistry/removal model analysis are presented and discussed.

7293 (LBL—20261, pp 38-40) **Oxidation rates of $SO_2$ in chimney plumes - observations on the importance of heterogeneous processes, based on some smelter and power plant plume studies.** Lusis, M.A. (Air Resources Branch, Toronto, Ontario). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Because of the importance of large point sources of $SO_2$, and the relative simplicity with which atmospheric chemistry studies can be carried out on point source plumes, there have been many plume investigations into $SO_2$ oxidation rates, under various meteorological condition. These studies have provided evidence for both heterogeneous and homogeneous $SO_2$ oxidation mechanisms. Depending on the geographical location, meteorological conditions and period of interest, either mechanism could conceivably be important. This paper presents some data collected at two locations in Canada - the Suncor power plant in the tar sands area of northern Alberta (57° N lat), and the large INCO nickel smelter at Sudbury, Ontario. The data discussed here are of interest because, due to a number of factors, heterogeneous processes would be expected to be significant, but homogeneous gas-phase chemistry should be negligible. The absence of appreciable conversion rates under the conditions of these experiments (notably high particulate loadings and low solar radiation in the Suncor case, and near -100% relative humidity in the INCO case) is used to argue against heterogeneous, particle catalyzed processes as an important mechanism in chimney plumes.

7294 (LBL—20261, pp 41-43) **Empirical evidence for rapid heterogeneous sulfate formation in the Los Angeles urban airshed.** Zeldin, M.D.; Ellis, E.C.; Huang, A.A. (Southern California Edison Co., Rosemead). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The Los Angeles Basin (SOCAB) is a large urban airshed situated adjacent to the Pacific Ocean. Since the air entering the SOCAB is predominantly from overwater trajectories, the area affords an excellent opportunity to study the relationships between local emissions and resulting air quality without the confounding effects of long range emissions transport from other industrial or urban complexes. Furthermore, major industrial sources of sulfur oxides are generally concentrated along the coastal regions where the frequency of moisture availability (e.g. fog and stratus clouds) is greatest. With an understanding of the general meteorological processes which typically occur, analyses of aerosol sulfate, and rain and fog chemistry can unfold a reasonable and consistent picture of sulfur oxidation processes. This paper will present the results of such analyses from an empirical perspective.

7295 (LBL—20261, pp 44-45) **Direct evidence of the presence of atmospheric particles formed by heterogeneous processes.** Mamane, Y. (Technion, Haifa, Israel). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Observational evidence of heterogeneous reactions in the atmosphere, especially those of sulfur and nitrogen oxides, is still limited mainly because of the large number of possible chemical reactions which are suspected to occur during a lifetime of an observed species. Therefore, the role of heterogeneous processes cannot be determined until more data are gathered. Study of individual particles may provide some clues and answers regarding the formation of particles by heterogeneous chemical reactions, especially if the chemical reactions took place on the surfaces of existing atmospheric insoluble particles, or in water droplets which contained insoluble inclusions. A particle of this type, such as sulfate formed on soot, is called a mixed particle. The presence of mixed particles with distinct inhomogeneities in the atmosphere has been studied by different groups, mainly through the application of electron microscopy techniques to individual particles. The simplest technique to study mixed particles is observing the change in morphology or decomposition of particles before or after dialysis in a transmission electron microscope (TEM). More specific techniques involve the use of micro-spot techniques for the detection of sulfate and nitrate in individual particles, and the application of energy dispersive x-ray analysis (EDX) to obtain the elemental content of the insoluble inclusions within a mixed particle.

7296 (LBL—20261, pp 49-50) **Occurrence of inorganic and organic acidic components at four source-dominated sites in Europe (Vienna, Linz, Ljubljana, Bologna).** Puxbaum, H.; Weber, M.; Pech, G. (Technical Univ. Vienna, Austria). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The highest concentrations of nitrates (gaseous and particulate) and of sulfates were found in Linz. The high level of pollution is originating from the industrial district of the city, where nitric acid, sulfuric acid, fertilizers, plastics and many other chemicals are produced. The concentrations of acidic compounds at the sampling sites in Vienna and in the Po Valley are comparable to concentrations found in the Los Angeles area. The ratios of total nitrates versus total sulfates as well as of free acids versus ammonium salts were also comparable to the conditions found in the Los Angeles basin. In Ljubljana high concentrations of sulfuric acid and ammonium sulfate were observed whereas nitrate levels were relatively lower. In Vienna and in the Po Valley atmospheric concentrations of volatile organic acids and of inorganic acids were on an equivalent basis in a comparable range. In Ljubljana the concentration of sulfuric acid exceeded the concentrations of the volatile organic acids by a factor of 3.

7297 (LBL—20261, pp 51-53) **Source characterization of aerosols using elemental tracers.** Husain, L.; Canelli, E.; Dutkiewicz, V.A.; Parekh, P.P.; Webber, J.S. (New York State Dept. of Health, Albany). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Experiments were performed to study the behavior of sulfates and trace-element aerosols during atmospheric transport. An attempt was also made to determine if elemental ratios provide unique regional signatures. Concentrations of sulfates and selected trace elements were determined in air samples collected during summers at four rural New York State sites in 1981, four in 1982, and two in 1983. Trace elements sampled included As, Se, V, Br, Pb, Fe, Mn, Sc, Zn, and Sb. Results of this study indicate that certain elemental ratios may change during atmospheric transport and that when using elemental ratios as regional signatures at distant receptors this correction should be made. Furthermore, Mn, Zn, As, and Sb (relative to Se) do not yield unique regional signatures. Only V appears to be a true indicator for eastern aerosols.

7298 (LBL—20261, pp 54-56) **Sulfur-to-mass ratio distributions of urban aerosols at Vienna, Austria.** Berner, V.; Berner, A. (Universitaet Wien, Vienna, Austria). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The conversion of $SO_2$ to sulfurous aerosol material is still of high concern as sulfurous particles, acidic or neutral, are responsible for part of the aerosol effects on ecological systems. Homogeneous reactions by which condensable vapors are formed in the gas phase and heterogeneous reactions on the surface or in the volume of aerosol particles are the two groups of gas-to-particle conversion reactions. Whereas the products of heterogeneous reactions contribute directly to the mass and the volume of the reactor particles the materials of the homogeneous reactions form new particles or condenses on pre-existing ones. Physically, newly formed particles occur in the nucleation mode size range with diameters in the order of 10 nm. The material produced by heterogeneous reactions, however, should occur in the accumulation mode size range as most surface and mass size distributions of atmospheric aerosols are dominated by the accumulation mode. Low pressure impactors which classify the particle size range below 0.2 μm bring the nucleation mode into the reach of analytical chemistry.

7299 (LBL—20261, pp 57-59) **Size distribution of sulfates in the St. Louis urban aerosol: heterogeneous formation and visibility.** Vossler, T.L.; Macias, E.S. (Washington Univ., St. Louis, MO). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The extent to which sulfates produce visibility reduction in the St. Louis area was examined. The contribution of fine aerosol sulfates to total light scattering was calculated from measured sulfur size distributions and Mie theory of light scattering. The aerosol was collected during both a summer and a winter season. Short sampling intervals (10 minutes to 3 hours) permitted observation of the variation of the sulfur size distribution and concentrations, and involved only small changes in meteorology. Size separation was accomplished with an 8 stage low pressure impactor which yielded size fractions in the range of 4 μm ≧ d/sub p/ ≧ 0.05 μm. Elemental sulfur was measured by flash volatilization and flame photometric detection. Three types of sulfur size distributions were observed during the summer and were designated types A, B, and C. The most common types observed during the summer, types A and B, had a major sulfur mass peak between 0.5 μm and 1.0 μm in diameter. This particle size scatters light more efficiently than other particles. The winter sulfur aerosol could not be divided into different size distribution types. The measured light scattering coefficient, b/sub scat/, and $(NH_4)_2SO_4$ were extremely well correlated (r = 0.97) in the summer, but not as well correlated (r = 0.63) in the winter. Conversely, b/sub scat/ and non-sulfate fine mass were well correlated (r = 0.85) in the winter, but poorly correlated (r = 0.24) in the summer. The light scattering efficiency of $(NH_4)>SI_4$ plus associated water calculated from Mie theory and size distributions was 4.2 m²/g for the summer aerosol, but only 2.0 m²/g for the dry winter $(NH_4)_2SO_4$.

7300 (LBL—20261, pp 60-62) **Ultra-fine sulfur-containing aerosols in the west.** Cahill, T.A.; Elred, R.A.; Feeney, P.J.; Flocchini, R.G.; Pitchford, M.; Malm, W. (Univ. of California, Davis). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Behavior patterns of atmospheric particulate matter in the arid west differ sharply from those seen in more humid climates in the east and on the west coast. The DRUM sampler has been used to obtain statistically significant information on particulate matter by size, time, and composition. However, much more work is needed to characterize these ultra-fine particles, including better time resolution in the less than 0.12 μm size range. However, all data indicate that they are not just another aspect of the accumulation mode but represent different types of particles. Thus, accumulation mode sulfur may represent sulfur dioxide to sulfate conversion while the ultrafine mode reflects primary emissions made ever finer during transport.

7301 (LBL—20261, pp 63-65) **Aerosol characterization in Beijing, China - 1983/1984.** Dod, R.L.; Giauque, R.D; Novakov, T.; Weihan, S.; Qiupeng, Z.; Wenzhi, S. (Univ. of California, Berkeley). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Verification of the contributions of the various mechanisms to the sulfate burden in the atmosphere of the United States has been complicated by the relatively low concentrations of pollutants and the great variety of fuels and combustion source types present. To study this problem in a simpler environment, the author have established a sampling site in Beijing, China, a location that is subject to a large pollutant impact from a limited variety of combustion sources whose emissions are not so tightly controlled as are those in the United States. Presented here are results of analyses of the initial set of filter samples, covering approximately 1 year. Daily 24-hr filter samples of ambient aerosol parties were collected in a densely populated part of Beijing, using a sampler designed for the simultaneous collection of two low-volume samples on 47-mm diameter filters. One filter was Pallflex 2500 QAO quartz fiber that had been fired at 800°C for 4 hr to remove the organic binder; the other filter was Millipore RAWP cellulose ester. The sampling program was arranged to cover approximately three seasons - spring, summer, and winter. Total carbon and particulate sulfur were determined for every sample pair collected. The chemical form of the sulfur determined by x-ray fluorescence (XRF) analysis was established by ion chromatography (IC). The only significant sulfur species seen with IC under the operating conditions was sulfate, which accounted for all the sulfur seen by XRF. Samples from March, July, and December 1983 were selected for a complete x-ray fluorescence analysis for all trace elements. Most samples from these three months were also analyzed by thermal evolved gas analysis (EGA) to determine their primary carbon or soot content. Results from these analyses, together with rudimentary meteorological information and $SO_2$ concentrations, constitute the complete data base.

7302 (LBL—20261, pp 66-68) **Chemistry and corrosiveness of dew.** Wilson, W.E.; Edney, E.. Stiles, D.C. (Environmental Protection Agency, Washington, DC). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Increased attention has been given recently to the impact of the deposition of acidic species on the degradation of commercially important materials such as metals and paints. Although it has been appreciated for some time that air pollutants, especially $SO_2$, can accelerate atmospheric corrosion and erosion processes, it has only been in the past few years that an aggressive effort has been made to develop damage functions that can be employed to predict the extent of corrosion or erosion for a given set of environmental conditions. In order to evaluate the economic impact of various control strategies, reliable damage functions must be developed to predict the impact of a reduction in ambient $SO_2$ concentration or the pH of the rain on the degradation process. As a first step in the development of such models the authors have conducted a series of laboratory experiments to clarify the role of a number of air pollutants in the atmospheric corrosion of galvanized steel, a commercially important metal alloy used extensively throughout the United States. In particular, the authors focus on the corrosion of galvanized steel in the presence of dew. Experiments were conducted where galvanized steel was exposed to all matrices that contained the following mixtures: (1) $SO_2$, (2) $NO_2$, (3) irradiated $C_3H_8$/NO/sub x/, and (4) irradiated $C_3H_8$/NO/sub x//$SO_2$. During the short-term exposures dew was produced periodically on the test panels, collected and analyzed for its chemical contents. The focus of this work was on the composition of the soluble corrosion products.

7303 (LBL—20261, pp 69-71) **$H_2SO_4$ - $HNO_3$ - $NH_3$ system at high humidities and in fogs.** Jacob, D.J.; Waldman, J.M.; Hoffmann, M.R. (California Institute of Technology, Pasadena, CA). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

A systematic characterization of the atmospheric $H_2SO_4$ - $HNO_3$ - $NH_3$ system was conducted in the fogwater, the aerosol, and the gas phase at a network of sites in the San Joaquin Valley of California. Spatial patterns of concentrations were established that reflect the distribution of $SO_2$, NO/sub x/, and $NH_3$ emissions within the valley. The concept of atmospheric alkalinity was introduced to interpret these concentrations in terms of the buffering capacity of the atmosphere with respect to inputs of strong acids. Regions of predominantly acidic and alkaline fogwater were identified. Fogwater was found to be alkaline in most of the valley, but small changes in emission budgets could lead to widespread acid fog. An extended stagnation episode was studied in detail: progressive accumulation of $H_2SO_4$ - $HNO_3$ - $NH_3$ species was documented over the course of the episode, and interpreted in terms of production and removal mechanisms.

7304 (LBL—20261, pp 72-74) **Heterogeneous processes in fog.** Fuzzi, S.; Orsi, G.; Nardini, G. (Instituto FISBAT - CNR, Bologna, Italy). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

It has been shown that fog water can be highly concentrated in $H^+$, $NH_4^+$, $NO_3^-$, $SO_4$/sup =/ ions in polluted atmospheres. Different mechanisms are responsible for the fog water chemical composition: (a) nucleation scavenging: fog droplets grow by water vapor condensation on preexisting aerosol particles; (b) scavenging of gas and particles during fog evolution: several physical mechanisms act during fog evolution, causing the incorporation of gas and particles which modify the droplet chemical composition; (c) chemical reactions in the dispersed liquid phase: $SO_2$ and NO/sub x/ can be oxidized in solution to $H_2SO_4$ and $HNO_3$ respectively; (d) fog microphysical evolution: fog water chemical composition is also a function of the temporal variations of the droplet size distribution. The evaluation of the relative importance of these mechanisms in determining the chemical composition of fog water is the main goal of this study.

7305 (LBL—20261, pp 75-76) **Chemical deposition from radiation fog.** McLaren, E.; Fuzzi, S. (State Univ. of New York, Albany). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Wet deposition seems to be the most important removal process for strong acids from the atmosphere. Most of the free protons forming such acidity is associated with sulfate, nitrate and chloride ions. Detailed knowledge of the physical and chemical steps leading from the gaseous and particulate precursors to the deposition of the acids and their salts in aqueous droplets is a necessary part of any predictive model useful for understanding and controlling accumulation and/or concentrations deposited within specific regions. Radiation fog provides a particularly favorable situation for the study of these processes. Because of the relatively stable and calm fog conditions, it can be treated as a quasi-closed system, enabling the powerful tool of mass balance to be applied to the full cycle of transformation of condensation-evaporation with associated gas/aerosol entrapment, deposition and release back to the atmosphere in possibly different forms. Information derived from these studies can then be helpful for understanding more complex meteorological situations such as cloud deposition into mountain forests.

7306 (LBL—20261, pp 77-79) **In-cloud oxidation of $SO_2$ as deduced from trace elements in aerosol and precipitation.** Heaton, R.; Rahn, K.A. (Univ. of Rhode Island, Narragansett). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

During the past year, the authors have developed and begun to apply a sampling and analytical technique for precipitation which can measure nearly as many elements (30-40) as in the parent aerosol. Rain is collected in a polyethylene bag mounted directly under a simple polyethylene funnel. Typically, up to 500 ml are accumulated; sampling begins only after the rain has started. Snow is scooped into the same kind of bag during or shortly after the event; up to 500 ml are accumulated by repeated sampling and melting in the laboratory. The bags are sealed, frozen overnight, then opened and freeze-dried until all the ice has disappeared. The bag and its contents are then analyzed by instrumental neutron activation at the Rhode Island Nuclear Science Center. Sulfate is determined from a small aliquot of the precipitation removed before it is frozen. For comparison, aerosol samples taken before, during, and after the event are analyzed similarly. The principal goal of this research is to develop procedures for applying the University of Rhode Island's regional elemental tracer system, originally to use the patter of trace elements in precipitation to determine the fraction of the sulfate which has been produced by in-cloud oxidation of $SO_2$, as opposed to direct scavenging of sulfate from aerosol.

7307 (LBL—20261, pp 81-82) **Relative times for sulfate accumulation in fog.** Stelson, A.W.; Kiang, C.S.; Fuzzi, S. (Atlanta Univ. Center Inc., GA). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

This paper is an initial evaluation of the various pathways leading to pollutant enrichment and acidification of fog water by sulfate. After extensive literature research and analysis of the chemistry and physics of the atmospheric fog environment, the authors conclude that eleven common mechanisms exists for the accumulation of sulfate in fog water. These mechanisms are diffusion of sulfur dioxide to a droplet followed by rapid oxidation, surface reaction of sulfur dioxide on the surface of a droplet, droplet growth by water condensation on pre-existing aerosol, scavenging by aerosol diffusion to the droplet, scavenging by aerosol coagulation with the droplet, iron catalyzed oxidation of sulfite, manganese catalyzed oxidation of sulfite, carbon catalyzed oxidation of sulfite, ozone oxidation of sulfite, hydrogen peroxide oxidation of sulfite and oxygen oxidation of sulfite. Aqueous free radical mechanisms were not evaluated because many of the reaction rates are speculative and need to be verified by field and laboratory experimental investigations. The maximum pollutant concentrations for the San Pietro Capofiume site were evaluated and substituted into the mechanistic specific expressions for the amount of time to accumulate 100 $\mu$M sulfate in fog water. The calculated accumulation times are summarized as a function of fog droplet diameter.

7308 (LBL—20261, pp 83-85) **Experimental design of wet scavenging studies in urban-source-dominated regions.** Tanner, R.L.; Patrinos, A.A.N.; Daum, P.H. (Brookhaven National Lab., Upton, NY). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Experiments were performed in an attempt to study the relationship between emission sources of sulfur and nitrogen oxides into the boundary-layer troposphere, and the subsequent wet and dry deposition of their oxidation products, sulfate and nitrate, at the earth's surface. The studies were conducted in 1983-1984 in the Philadelphia, Pennsylvania area, at which location emission sources of sulfur and nitrogen oxides are fairly well known and concentrated within this area. Storms with relatively uniform rainfall and wind fields were sampled at approximately 40 sites. Results from these storms showed significant nighttime/daytime differences in nitrate, sulfate deposition. Additional experiments were conducted in 1985 within and near the same area. In contrast to previously sampled storms, preliminary data suggest that target deposition of sulfate in nighttime storms, although variable, averaged 50% greater than control deposition, and that excess sulfate deposition exceeded nitrate deposition. Surface precipitation in the control region frequently contained $>10$ $\mu$m of $H_2O_2$ whereas most target region samples contained $<1$ $\mu$m $H_2O_2$. These results suggest that aqueous-phase oxidation of dissolved sulfur dioxide in cloudwater or rain may have caused a significant portion of the observed excess deposition of sulfate in the target region.

7309 (LBL—20261, pp 86-88) **Measurement of $H_2O_2$ without ozone interference.** Groblicki, P.J.; Ang, C.C. (General Motors Labs., Warren, MI). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Commonly used methods for the measurement of gaseous $H_2O_2$ in the atmosphere concentrate the gaseous $H_2O_2$ into water, and measure the $H_2O_2$ in the liquid sample. These methods are subject to an interference when coexisting ambient $O_3$ dissolves in the water and produces artifact $H_2O_2$. Based upon summertime sampling in Warren, MI, the interference averages 15% for the continuous analyzer described here and about 50% for the more commonly used batch-bubbler technique. The $O_3$ interference is completely removed by adding 1 ppm of NO to the inlet air stream, allowing a half minute resident time in a pre-reactor, then sampling with either a continuous analyzer or a bubbler.

7310 (LBL—20261, pp 89-90) **Sampling of gas phase compounds with diffusion denuders.** Eatough, D.J.; Lewis, E.A.; Hansen, L.D. (Brigham Young Univ., Provo, UT). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The sampling of compounds which may be present both in aerosols and in the gas phase in the atmosphere presents a significant analytical problem. Two general approaches have been used to separate the gas and aerosol phases of any given compound. The first approach separates the two phases by first removing particulate matter with a filter which does not remove the gas phase material and then removing the gas phase component by a suitable adsorption bed placed after the filter. This sampling method assumes that prolonged exposure of the collected aerosol to gases does not result in subsequent lose of material to or gain of material from the gas phase by the collected aerosol during sampling. The second approach involves removal of the gas phase from the particle phase using a diffusion denuder, followed by collection of the remaining material by a filter-adsorption bed combination after the denuder. This sampling technique assumes that the residence time in the denuder is short enough that no volatilization of material from aerosols occurs during the passage through the denuder.

7311 (LBL—20261, pp 91-94) **Experimental comparison of $^{18}O/^{16}O$ ratios in $H_2O_2$, $H_2O$, and $SO_4^{2-}$ in rainwater.** Holt, B.D.; Kumar, R. (Argonne National Lab., IL). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

The authors are investigating the usefulness of oxygen isotope ratio ($^{18}O/^{16}O$) measurements in the elucidation of the role of $H_2O_2$ in the oxidation of $SO_2$ to sulfates in the atmosphere. The potential importance of examining the $H_2O_2$-oxidation mechanisms lies in the view that aqueous-phase oxidation of $SO_2$ to $H_2SO_4$ probably accounts for a major fraction of the observed sulfates in the precipitation occurring in the northeastern United States. It has been postulated that atmospheric oxidation of $SO_2$ is limited by the availability of $H_2O_2$ and $O_3$ rather than by the availability of $SO_2$ itself. If such is indeed the case, it is important to evaluate the role of $H_2O_2$ in acid formation and deposition from the atmosphere. The plan of this investigation has been to develop a method for the determination of the $\delta^{18}O$ of $H_2O_2$ in dilute aqueous solutions (simulating rainwater); to prepare $H_2O_2$ of various $^{18}O$ enrichments (in aqueous solutions); to use the freshly prepared solutions of $H_2O_2$ to oxidize $SO_2$ to $SO_4^{2-}$ for evaluation of the relationship between $\delta^{18}O$/sub $SO_4^{2-}$/ and $\delta^{18}O$/sub $H_2O_2$/; and to apply this relationship to the measured $\delta^{18}O$/sub $H_2O_2$/, $\delta^{18}O$/sub $SO_4^{2-}$/, and $\delta^{18}O$/sub $H_2O$/ in precipitation water, for assessment of the importance of $H_2O_2$ in the atmospheric transformation of $SO_2$ to sulfate.

7312 (LBL—20261, pp 96) **Organic matter in acid rain water.** Kaplan, I.R.; Kawamura, K. (Univ. of California, Los Angeles). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Volatile and extractable organic substances were analyzed in SCAB rain and fog samples during the past three years. Methods have been developed for measuring a wide range of organic substances, including hydrocarbons, ketones, organic acids, and aldehydes. In particular, methods have been developed to measure low molecular weight acids and aldehydes, both in wet precipitation and in the atmospheric gas phase. The results indicate that up to 20% of the hydrogen ion content in rain may be contributed by organic acids at some southern California locations. These acids are in part liberated by automobile emissions and in part formed by oxidation in the atmosphere involving peroxides. Several indices have been established to differentiate ambient background contributions from anthropogenic emissions. These can be used to model changes in the meteorological conditions and sources of emissions during a rain storm.

7313 (LBL—20261, pp 96) **Mutagenicity of ambient aerosol.** Raunemaa, T.; Vartiainen, M.; Liimatainen, A. (Univ. of Kuopio, Finland). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Mutagenic compounds in urban air were studied by sampling 2000-4000 $m^3$ air in 2 day intervals by high volume samplers in the city of Kuopio, Finland. Heavy traffic produce heavy diesel pollution under certain meteorological conditions, especially in the wintertime. A 265 MW peat powerplant, with 80 m and 120 m high stacks is situated 2 km from the city center. A paper mill unit/km north and a mechanical wood processing factory in the neighborhood of the center produce additional air pollution. Monthly mean TSP value during sampling was 350 +/- 65 $\mu g/m^3$ with the highest value of 850 $\mu g/m^3$. The PM-10 concentrations were 105 +/- 15 $\mu g/m^3$, the maximum value being 210 $\mu g/m^3$. Fine particle mass was thus 32% of the TSP. Fine particle fraction was found to be higher, when TSP was low. Particulate samples were Soxhlet extracted for 18 h with dichloromethane. The samples (in DMSO) were tested in the Ames test using strains TA 98 and TA 100 with and without S9. Air mutagenicity levels between 3.3-14.7 rev/$m^3$ were obtained. Curiously, only 16% of the activity found in the fine particles was observed in the TSP (TA 100 +/- S9). The results were similar in both tester strains. If normalized to mass about 20 times higher mutagenicity can be attributed to fine mass.

7314 (LBL—20261, pp 97-99) **Products of reaction of particulate-adsorbed benzo(a)pyrene under simulated atmospheric conditions.** Daisey, J.M.; Boone, P.M. (New York Univ. Medical Center, NY). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

Rates of reaction of polycyclic aromatic hydrocarbons (PAH) have been shown to depend upon the nature of the particle on which the PAH are adsorbed. For pyrene, there is also evidence that particle substrate influences the products of reaction. The authors report here differences in the product distributions for the reaction of benzo(a)pyrene (BaP), adsorbed on 4 different particle substrates, exposed to dry air and light. The particles used were: fumed silica, carbosieve S (a carbon), anatase $TiO_2$, and coal fly ash.

7315 (LBL—20261, pp 100-102) **Origin and deposition history of polycyclic aromatic hydrocarbons in the Finger Lakes region of New York as determined from Cayuga Lake sediments.** Heit, M.; Miller, K.M.; Tan, Y.L. (Dept. of Energy, New York, NY). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

In recent years concern has arisen over the source, concentrations and deposition rates of pollutants other than nitrogen and sulfur oxides which are depositing in the environment and may cause deleterious effects to sensitive ecosystems and possibly human health. PAH are among the most important classes of these energy-related pollutants since they include several compounds which are known human carcinogens or mutagens. It is the aim of the research reported here to establish the sources and atmospheric deposition rates and to project future trends of PAH deposition in the Finger Lakes region of Central New York State as preserved and reconstructed from the record in the sediments of Cayuga Lake. This area is of considerable interest since the Finger Lake region was among the first in the US shown to receive acidic precipitation and by inference other energy-related pollutants.

7316 (LBL—20261, pp 103-105) **Meteorology and characteristics of acid air episodes in western New Jersey.** Thurston, G.D.; Lioy, P.J. (New York Univ., Tuxedo). Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

As part of an ongoing study of the respiratory effects of airborne acidity, acid aerosol measurements were made during July and August 1984 at a children's summer camp located 20 km. northeast of the Delaware Water Gap in western New Jersey. The primary impetus for this study was suggestive evidence that breathing acidic particles such as sulfuric acid ($H_2SO_4$) and ammonium bisulfate ($NH_4HSO_4$) is potentially injurious to human health. Furthermore, the camp is situated along the Kittatinny Ridge, which is an environmentally sensitive area where acid deposition effects on lakes have been reported. Thus, investigations of the nature and

sources of acid aerosol events at this site are of interest from both human health and environmental perspectives.

7317 (LBL—20261, pp 106-107/108) **Microencapsulation of aerosol particles and fog droplets for combined physical and chemical characterization.** Otto, R.J.; Jaklevic, J.M. Nov 1985. NTIS, PC A06/MF A01. File Number DE86009469. (CONF-851077—Summs.).

From Symposium on heterogeneous processes in source-dominated atmospheres; New York, NY, USA (8 Oct 1985).

In the present work, the authors describe the use of X-ray powder diffraction and scanning electron microscopy to study heterogeneous phase chemistry that occurs on the surface of the filter media after aerosol sampling. The use of microencapsulation as a method to inhibit chemical activity following particle deposition has been demonstrated. Experiments have shown that the sequential deposition of submicrometer ammonium sulfate and lead chloride onto Teflon filters at relative humidities of 5% or less results in the formation of ammonium lead chloride, ammonium bisulfate, and letovicite. The encapsulation of the ammonium sulfate prior to the deposition of lead chloride on the same filter greatly reduces this reaction. Subsequent hydration of the filters by drawing humid air (greater than 60% r.h.) through the filter results in the transformation of the particles on the filter to ammonium lead sulfate crystals. Encapsulation of the ammonium sulfate before addition of the lead chloride inhibits this reaction. A related effort involves the preferential orientation of ammonium sulfate crystals (mascagnite) that is observed in x-ray powder diffraction measurements following the exposure of the sample to high ambient relative humidity. The pretreatment of the submicrometer ammonium sulfate with MCA presents this apparent dissolution and recrystallization. This mechanism, whereby the microencapsulation of the particle is achieved, has been studied in a related series of experiments that will be briefly described.

7318 (MAP-HANDBK—8, pp vp) **Measurements of CCl3F, CCl2F2, CCl4, N2O and SF6 in the Northern Hemisphere stratosphere.** Leifer, R.; Juzdan, R. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

An overview of the Department of Energy's High Altitude Sampling Program and some recent trace gas measurement results are presented. Analysis of whole air samples, collected in pressurized bottles, provides information on stratospheric inventories and distributions for CCl3F, CCl2F2, CCl4, N2O and SF6 in the Northern Hemisphere. Based on a linear regression analysis of the data the estimated mean Northern Hemisphere stratospheric concentration of each gas increased as follows: CCl3F changed from 54 to 142 p1/1 (4/74-11/83); CCl2F2 changed from 133 to 268 p1/1 (4/76-11/83); SF6 changed from 160 to 480 f1/1 (4/74-11/83); CC1, changed from 58 to 91 p1/1 (4/75-11/83); N2O changed from 246 to 261 n1/1 (4/76-11/83). The calculated mean Northern Hemisphere stratospheric concentrations of N2O, CCl3F, CCl2F2, and CCl4 after 1980 show larger than expected fluctuations with time. Recent volcanic activity may be a partial cause for these fluctuations through induced changes in stratospheric dynamical processes.

7319 (MAP-HANDBK—8, pp vp) **Atmospheric concentrations and behavior of halocarbons and methane.** Makide, Y.; Yokohata, A.; Tominaga, T. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

The atmospheric concentrations of halocarbons and methane in the troposphere and stratosphere were precisely measured by grab-sampling followed by gas-chromatographic analysis in the laboratory. Chlorofluorocarbons such as CCl2F2 and CCl3F have received a great deal of attention due to their probable impact on the stratospheric ozone: the chlorofluorocarbons accumulated in the troposphere are eventually decomposed by photolysis in the stratosphere releasing Cl radicals which in turn participate in the ClO sub x-catalytic chain destroying the ozone, especially in the upper stratosphere. Methane reacts with Cl in the stratosphere reducing the ozone depletion, while its source and future trend of concentration in the troposphere are uncertain. The study of their distribution and behavior in the atmosphere are therefore very important. After the extensive survey of the locations for collection of atmospheriic samples representing the midlatitudes Northern Hemisphere (N.H.) without local contamination, we have measured the concentrations of CCl2F2, CCl3F, CH3CCl3, CC1, CHCl=CCl2 and CCl2=CCl2 with plus or minus 1 pptv precision in samples collected in Hokkaido and west coast Tohoku area (the northern part of Japan, 40 deg to 45 deg N) every summer and winter since 1979. The observed concentrations of CCl2F2 and CCl3F are now above 360 and 200 pptv, respectively, and have been steadily increasing by approx. 15 and approx. 8 pptv/year during the last several years.

7320 (MAP-HANDBK—8, pp vp) **Measurements of concentrations of chlorofluoromethanes (CFMs) carbon dioxide and carbon isotope ratio in stratospheric and tropospheric air by grab-sampling systems.** Itoh, T.; Kubo, H.; Honda, H.; Tominaga, T.; Makide, Y.; Yakohata, A.; Sakai, H. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Measurements of concentrations of chlorofluoromethanes (CFMs), carbon dioxide and carbon isotope ratio in stratospheric and tropospheric air by grab-sampling systems are reported. The balloon-borne grab-sampling system has been launched from Sanriku Balloon Center three times since 1981. It consists of: (1) six sampling cylinders, (2) eight motor driven values, (3) control and monitor circuits, and (4) pressurized housing. Particular consideration is paid to the problem of contamination. Strict requirements are placed on the choice of materials and components, construction methods, cleaning techniques, vacuum integrity, and sampling procedures. An aluminum pressurized housing and a 4-m long inlet line are employed to prevent the sampling air from contamination by outgassing of sampling and control devices. The sampling is performed during the descent of the system. Vertical profiles of mixing ratios of CF2Cl2, CFCl3 and CH4 are given. Mixing ratios of CF2Cl2 and CFCl3 in the stratosphere do not show the discernible effect of the increase of those in the ground level background, and decrease with altitude. Decreasing rate of CFCl3 is larger than that of CF2Cl2. CH4 mixing ratio, on the other hand, shows diffusive equilibrium, as the photodissociation cross section of CH4 is small and concentrations of OH radical and 0(sup I D) are low.

7321 (MAP-HANDBK—8, pp vp) **Gas-chromatographic measurements of atmospheric CF2Cl2, CFCl3 and N2O in Antarctica.** Hirota, H.; Makino, Y.; Chubachi, S.; Muramatsu, H.; Shiobara, M. (Tohoku Univ., Sendai, Japan). Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Stratospheric ozone is produced photochemically and destroyed by reactions with such minor constituents as O, NOx, HOx, and ClOx. Chlorofluoromethanes (CF2Cl2 and CFCl3) and dinitrogen oxide (NwO) are considered as major sources of the stratospheric ClOx and NOx, respectively. It is well known that CF2Cl2 and CFCl3 are released only by man's activities, and are being accumulated in the troposphere. In order to assess the influence of these compounds on the natural ozone balance these gases have been measured over Japan since 1978. Measurements of Antarctic air samples are also indispensable to understanding the global distributions of these gases, because most CF2Cl2 and CFCl3 have been released in the Northern Hemisphere. Antarctic air samples were obtained by the 23rd, 24th and 25th Japanese Antarctic Research Expeditions, and analyzed by a gas-chromatographic method using an electron capture detector. Three experimental results were obtained: (1) latitudinal distribution of these gases from Tokyo to Syowa Station (69.0 deg S, 39.6 deg E), (2) time trends at Syowa Station, and (3) vertical distributions over Syowa Station. Results are reported.

7322 (N—86-29301, pp vp) **Thermospheric nitric oxide and its role in thermospheric dynamics and composition.** Gerard, J.C.; Roble, R.G. (National Center for Atmospheric Research, Boulder, CO). Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

The global distribution of thermospheric nitric oxide has been measured under different geophysical conditions by the Atmosphere Explorer (AE) and Solar Mesosphere Explorer (SME) satellites. These observations show a great variability in the NO concentration but the existence of a latitudinal gradient is clearly evidenced by statistical maps of the NO meridional distribution. A two dimensional zonally averaged chemical-dynamical model was used to investigate the importance of nitric oxide 5.3 micrometer cooling and its role on thermospheric temperature, dynamics and major gas composition. For this purpose, a 2-D background atmosphere code and an odd nitrogen code were coupled and run to steady state. The NO distribution obtained is in good agreement with the AE-D global picture calculated at solstice for solar minimum activity. The importance of each term in the thermodynamic equation was studied spatially. It is found that the NO I.R. cooling term competes with conduction in the upper thermosphere and reaches its maximum value near 200 km at high summer latitudes. The primary effect of including the NO cooling term is to increase the temperature in the upper winter thermosphere and decrease it in the other hemisphere, if the global average temperature is fixed. In general, the strength of the circulation is decreased and the thermal gradient is smoother. As a consequence of these changes in the wind and temperature fields, the O2, N2 and O densities also react to the effect of the NO cooling. The importance of this process depends on the level of solar activity which controls the NO distribution.

7323 (PB—86-222361/XAB) **UNAMAP: user's network for applied modeling of air pollution, Version 6. Model.** Turner, D.B.; Busse, A.D. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Aug 1986. vp. NTISCP T99.

Supersedes PB—83-244368; Source tape is in the ASCII character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only Call NTIS Computer Products for price. Price includes 35 related documents.

UNAMAP (Version 6) represents the 1986 update to the users network for applied modeling of air pollution. UNAMAP consists of an ASCII magnetic tape containing FORTRAN codes an test data for 25 air-quality simulation models (AQSM) as well as associated documentation. AQSM's and supporting programs and data are arranged in six sections: (1) Guideline (appendix A) models..(files 2 through 9); (2) Other models or processors (new models). .(files 10 through 19 and 33); (3) Other models and processors (revised)..(files 20 through 27 and 32); (4) Additional models for regulatory use (files 28 through 31); (5) Data files..(files 34 through 39); and (6) Output print files..(files 40 through 68). There are 68 files on this tape..Software Description: The system is written in FORTRAN for implementation on a UNIVAC 1100/82 using the 39R2 operating system.

7324 (PB—86-236148/XAB) **Health-hazard evaluation report HETA-84-043, HETA 84-425-1680, Montana log home residents, Kalispell, Montana.** Lee, S.A. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Apr 1986. 19p. (HETA—84-043). NTIS, PC A02/MF A01.

Environmental and urine sampling was conducted in 15 log homes in Montana previously treated with wood preservatives containing pentachlorophenol (PCP). The Montana Department of Health had requested assistance in evaluating exposures to PCP among state residents in PCP-treated log homes.

7325 (PB—86-236155/XAB) **Preliminary survey report: evaluation of brake-drum-service controls at Ohio Department of Transportation, Maintenance Facility, Lebanon, Ohio.** Sheehy, J.W. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Jul 1986. 8p. (ECTB—152-18A). NTIS, PC A02/MF A01.

The Ohio Department of Transportation, Maintenance Facility, Lebanon, Ohio, was visited as part of a study of asbestos control during the maintenance and repair of vehicular brakes. The effectiveness of various control technologies designed to reduce asbestos exposure were evaluated.

7326 (PB—86-236171/XAB) **Progress toward developing a monitoring method for hydrogen cyanide in air.** Cassinelli, M.E. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Physical Sciences and Engineering). 15 May 1986. 18p. NTIS, PC A02/MF A01.

The development of an analytical procedure for measuring free cyanide, the various solid and liquid sorbents tested, and the instability problems encountered during research to establish a monitoring method for hydrogen-cyanide (HCN) in air are described. The original goals of the project were the development of improved sampling and analytical methods for hydrogen fluoride, HCN, and particulate cyanides by replacing liquid-impinger samplers with solid sorbent samplers and using an ion-chromatographic analytical technique.

7327 (PB—86-236189/XAB) **Industrial-hygiene in-depth survey report, Papaya Packing/Shipping Facilities, Hilo, Hawaii.** Clapp, D.E. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Industrial Hygiene Section). Jun 1986. 37p. (IWS—64.17). NTIS, PC A03/MF A01.

An industrial hygiene survey was conducted at the Papaya Packing/Shipping facilities, Hilo, Hawaii to investigate worker exposure to ethylene dibromide used for pest control in fruit packing plants.

7328 (PB—86-236197/XAB) **Health-hazard evaluation report HETA 85-152-1684, Milprint, Inc., Depere, Wisconsin.** Kramkowski, R.S.; Orris, P. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Apr 1986. 18p. (HETA—85-152-1684). NTIS, PC A02/MF A01.

The possible risk of chronic respiratory disease or cancer during the manufacture of printed and coated food-wrapping materials was investigated at Milprint, Inc., DePere, Wisconsin. The evaluation was requested due to concern that a risk of pulmonary sensitization and cancer might exist from worker exposures to chemicals.

7329 (PB—86-236809/XAB) **Studies of dry acid deposition in the South Coast Air Basin: intermethod comparison of procedures for nitric acid and ammonia. Final report, 29 July 1985-28 July 1986.** Appel, B.R.; Tokiwa, Y.; Kothny, E.L.; Wu, R.; Povard, V. (California Dept. of Health Services, Berkeley (USA). Air and Industrial Hygiene Lab.). Mar 1986. 94p. NTIS, PC A05/MF A01.

A field study was performed at Claremont, CA to evaluate methods for the measurement of atmospheric nitric acid, fine particulate nitrate, and gaseous ammonia. The methods employed for nitric acid were the automated, semi-continuous tungstic acid technique (TAT) and the denuder difference method (DDM). Ammonia was measured with the TAT, a filterpack and a manual denuder tube collection method. Sampling was done in September 1985 in parallel with about 18 other research groups. Comparison of the present results to those from other groups is generally beyond the scope of the report. However, a comparison of $HNO_3$ values with those by a spectroscopic method employed is included herein. The DDM for nitric acid appears to be accurate within about 20%, while the TAT is subject to large variability. Daytime results at Claremont generally show agreement between the TAT and DDM but TAT results are much higher at night. Similarly, TAT ammonia results are uncertain by about a factor of 2.

7330 (PB—86-237138/XAB) **Health-hazard evaluation report HETA 84-379, HETA 84-495-1687, Metal Container Corporation, Columbus, Ohio.** Ruhe, R.L.; Arnold, S.J.; Anastas, M. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Apr 1986. 28p. (HETA—84-379). NTIS, PC A03/MF A01.

Health-hazard evaluations were undertaken at the Metal Container Corporation, Columbus, Ohio in the Automatic Banding Area (HETA 84-379) and the Printer Oven Area (HETA 84-495), in response to employee complaints about smoke, fumes, and chemical exposure.

7331 **(PB—86-237278/XAB) Preliminary industrial-hygiene survey report of Conley Corporation, Tulsa, Oklahoma.** Boeniger, M. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Jun 1986. 19p. (IWS—143.20). NTIS, PC A02/MF A01.

In July, 1984, a preliminary industrial-hygiene survey was performed at Conley Corporation, Tulsa, Oklahoma, where 4,4'-methylene-dianiline (4,4'-MDA) is used as a hardening agent in manufacturing fiberglass epoxy pipe and pipe fittings. Air and hand contact samples from 2 of 6 workers tested showed 4,4'-MDA contamination. Workers with potential exposure wore neoprene rubber gloves. Workers with direct contact with uncured resin wore a medium-weight flock-lined neoprene glove and a heavy rubber glove over the inner glove when handling the resin. Half-face respirators were available for mixing-room workers. These respirators use combination dust/organic vapor replaceable cartridges. Detectable exposure to airborne 4,4'-MDA was noted for two individuals, the extrusion resin mixer and a winding operator at the extrusion fittings machine, 0.011 and 0.0005 $mg/m^3$, respectively, each below the present voluntary guideline of 0.8 $mg/m^3$.

7332 **(PB—86-237658/XAB) Preliminary industrial-hygiene survey report of Fibercast Company, Sand Springs, Oklahoma. Industrywide survey.** Boeniger, M. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Jun 1986. 23p. (IWS—143.19). NTIS, PC A02/MF A01.

A preliminary industrial-hygiene survey was performed at the Fibercast Company, Sand Springs, Oklahoma to collect data related to characterizing potential worker exposure to 4,4'-methylenedianiline (4,4'-MDA) during the manufacture of fibrous-glass epoxy pipe and pipe fittings.

7333 **(PB—86-237666/XAB) Industrial-hygiene walk-through survey report of Copolymer Rubber and Chemical Corporation, Baton Rouge, Louisiana. Industrywide study.** Roberts, D.R.; Krishnan, E.R. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). Jun 1986. 27p. (IWS—147.22). NTIS, PC A03/MF A01.

A walk through survey was conducted at the Copolymer Rubber and Chemical Corporation, Baton Rouge, Louisiana. The facility produces 465 million pounds of styrene butadiene rubber (SBR) and 15 million pounds of nitrile butadiene rubber (NBR) annually, requiring 120 million pounds of 1,3-butadiene. Of 470 employees, 143 were directly involved in reaction, recovery, and finishing operations, and were potentially exposed to 1,3-butadiene 8 hours per day.

7334 **(PB—86-237682/XAB) Quality-assurance and quality-control plan for the NAPAP (National Acid Precipitation Assessment Program) 1985 emission inventory. Final report, October 1985-January 1986.** Pahl, D.A.; Mobley, J.D. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). Aug 1986. 46p. (EPA—600/8-86/025). NTIS, PC A03/MF A01.

This report identifies objectives that must be met to create an accurate and comprehensive inventory of 1985 emissions from anthropogenic sources thought to be important in acid deposition processes. Most of the 1985 emissions inventory data for this inventory are being collected and analyzed by state air-pollution-control agencies and the U.S. EPA. The report reviews data-quality objectives, priorities, and constraints for the collection of the 1985 inventory data.

7335 **(PB—86-237716/XAB) Fabric filter inspection and evaluation manual. Final report.** Roeck, D.R.; Dennis, R. (GCA Corp., Bedford, MA (USA). GCA Technology Div.). Feb 1984. 210p. (GCA-TR—80-114-G). NTIS, PC A10/MF A01.

The manual was prepared to assist Federal and State enforcement groups in the following decision-making areas: estimation of filter-system (baghouse) compliance with emissions regulations; appraisal of filter-system adequacy for a specific control application; and evaluation of operating and maintenance procedures in the light of recommended practices. In Chapter 2, basic concepts pertaining to fabric filtration, particle behavior, and particle-size measurements are highlighted so that inspection personnel can evaluate facilities for which no precedence has been established. Given prior experience or the need for immediate action, however, the manual user may go directly to Chapter 3 where important day-to-day aspects of filter-system operation are presented along with emphasis on what may go wrong and what remedial measures should be undertaken. Different types and procedures for baghouse inspections are described in Chapter 4; e.g., compliance determination, startup, troubleshooting, general preventitive maintenance, or special investigations, where the specific information sought and the sequence of the inspection process may vary.

7336 **(PB—86-240975/XAB) Synthesis and biological activity of nitro-substituted cyclopenta-fused PAH.** Goldring, J.M.; Ball, L.M.; Sangaiah, R.; Gold, A. (North Carolina Univ., Chapel Hill (USA)). Aug 1986. 19p. NTIS, PC A02/MF A01.

PAH containing a peripherally fused cyclopenta ring are genotoxically active in Salmonella and mammalian cells and have been identified in combustion emissions. Since the cyclopenta ring is predicted to be susceptible to electrophilic attack, nitrosubstituted cyclopenta-fused PAH may be formed in the presence of NO(x), particularly in diesel exhaust, and hence be present in the environment. Nitro derivatives of cyclopenta (cd) pyrene and the cyclopenta-fused benzanthracene isomers were prepared by reaction of the PAH with dinitrogen tetroxide. The purifed products were characterized by mass spectroscopy, (1)H NMR, UV-vis and HPLC. In all cases, nitro substitution occurred on the cyclopenta ring in accord with expectation. Preliminary assay in S. typhimurium indicates that 4-nitro-cyclopenta(cd)pyrene is mutagenically active without exogenous metabolic activation in nitroreductase-competent strains. The results of the study have allowed us to test the hypothesis and will aid in development of structure-activity relationships of nitroPAH.

7337 **(PB—86-241031/XAB) Addendum to TUPOS - incorporation of a hesitant-plume algorithm.** Turner, D.B. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Aug 1986. 39p. (EPA—600/8-86/027). NTIS, PC A03/MF A01.

The existance of non-Gaussian plume behavior within the convective boundary layer has been pointed out and recently discussed at a national conference. Briggs has suggested convective-scaling parameterizations for surface crosswind integrated concentrations. Combined with parameterization of the crosswind spreading and, assuming that the horizontal diffusion is Gaussian, allows estimation of concentrations on the horizontal plane. These techniques have been incorporated into an existing dispersion computer code to result in TUPOS-2.0.

7338 **(PB—86-241098/XAB) Particulate sampling and analysis. Book chapter.** Sparks, L.E. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). 1984. 50p. (EPA—600/D-86/188). NTIS, PC A03/MF A01.

Published in Handbook of Air Pollution Technology, Chapter 31, 785-832, 1984.

The chapter provides information needed to ensure that sampling and data analysis are well done. It discusses sampling and analysis associated with mass tests using EPA Test Methods 5 and 17 and particle-size distribution tests conducted with cascade impactors. All steps in the sampling and data analysis process are covered. Considerably more space is given to cascade impactors than to EPA Test Method 5, mainly because cascade impactors are more difficult to use and data reduction is difficult. Computer programs for reducing mass train and cascade impactor data are presented, along with quality-control recommendations.

7339 **(PB—86-241189/XAB) Volatile organic compound emissions: an inventory for Western Europe.** Edwards, A.H.; Campobasso, A.; Camps, R.; Cremer, G.; Long, M.D. (Concawe, The Hague (Netherlands)). 1986. 25p. (CONCAWE—2/86). NTIS, PC PC E03/MF E01.

The report gives details of an inventory compiled by CONCAWE and covering man-made non-methane volatile organic compound (VOC) emissions in Western Europe. The survey shows that the major man-made sources are road transport and solvents, each contributing around 40%. Total oil industry operations account for around 8%, with refining operations contribution about 2%. The major oil industry contribution comes from the distribution of gasoline, including vehicle refuelling (5%).

7340 **(PB—86-242450/XAB) INPUFF 2.0 - a multiple-source Gaussian puff dispersion algorithm. User's guide. Final report.** Petersen, W.B.; Lavdas, L.G. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Aug 1986. 118p. (EPA—600/8-86/024). NTIS, PC A06/MF A01.

For system on magnetic tape, see PB—86-222361. See also PB—86-242468.

INPUFF is a Gaussian Integrated PUFF model. The Gaussian puff diffusion equation is used to compute the contribution to the concentration at each receptor from each puff every time step. Computations in INPUFF can be made for single or multiple point sources at up to 100 receptor locations. In practice, however, the number of receptors should be kept to a minimum. In the default mode, the model assumes a homogeneous wind field. However, the user has the option of specifying the wind field for each meteorological period at up to 100 user-defined grid locations. Three dispersion algorithms are utilized within INPUFF for dispersion downwind of the source. Optionally the user can incorporate his own subroutines for dispersion and plume rise. Removal is incorporated through deposition and gravitational settling algorithms. A software plotting package is provided to display concentration versus time for a given receptor and the puff trajectories after each simulation time.

7341 **(PB—86-242468/XAB) Inpuff, multiple source puff model.** Petersen, W.B. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Aug 1986. 10p. (EPA—600/D-86/187). NTIS, PC A02/MF A01.

For system on magnetic tape, see PB—86-222361. See also PB—86-242450.

INPUFF is a Gaussian integrated PUFF model. The Gaussian puff diffusion equation is used to compute the contribution to the concentration at each receptor from each puff every time step. Computations in INPUFF can be made for a single or multiple point sources at up to 100 receptor locations. In practice, however, the number of receptors should be kept to a minimum. In the default mode, the model assumes a homogeneous wind field. However, the user has the option of specifying the wind field for each meteorological period at up to 100 user-defined grid locations. Three dispersion algorithms are utilized within INPUFF for dispersion downwind of the source. Optionally the user can incorporate his own subroutines for dispersion and plume rise. Removal is incorporated through deposition and gravitational settling algorithms. A software plotting package is provided to display concentration versus time for a given receptor and the puff trajectories after each simulation time.

7342 **(PB—86-242716/XAB) Feasibility and design study for the production and monitoring of synthetic-acid fogs and aerosols. Final report.** Young, J.R.; Landis, D.A. (Environmental Research and Technology, Inc., Newbury Park, CA (USA)). Jul 1986. 236p. NTIS, PC A11/MF A01.

A feasibility and design study to produce and monitor synthetic acid fogs and aerosols for human, animal, vegetation, and material exposure studies was conducted. Available data on the chemical and physical properties of California fogs and aerosols were reviewed to determine the observed ranges of chemical composition, droplet size, and liquid water content of fogs. The physical and chemical interactions that take place during fog events are discussed. A preliminary design for a portable system to produce, deliver, and monitor acidic fogs and aerosols in exposure chambers under controlled conditions was developed after a review of generation and monitoring methods to simulate and characterize acidic fogs and aerosols. Nine major exposure facilities were surveyed to determine their capability for conducting fog effects research with the system. Recommendations are made for: relevant sets of chemical and physical characteristics for exposure fogs and aerosols; specific fog/aerosol generation, delivery and monitoring equipment; and exposure facilities at which effect studies using the equipment could be conducted.

7343 **(PB—86-242757/XAB) Evaluation of rural air-quality simulation models. Addendum C: Kincaid $SO_2$ data base.** Cox, W.M.; Rorex, H.W.; Moss, G.K. (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Mar 1986. 134p. (EPA—450/4-83/003C). NTIS, PC A07/MF A01.

This addendum provides additional information regarding the performance of four rural air-quality simulation models using $SO_2$ air quality and a modelers data base assembled for the Kincaid Power Plant. The report contains numerous tabulations of each model's performance in terms of statistical measures recommended by the AMS. The four models evaluated included MPTER (EPA), PPSP (Martin Marietta Corp), MPSDM (ERT) and TEM-8A (Texas Air Control Board). Results from this evaluation were similar in many ways to those obtained from Clifty Creek and Muskingum River. PPSP clearly over-predicted concentrations in almost every data category while MPSDM, MPTER, and TEM exhibited relatively small but detectable biases depending on averaging period and data category.

7344 **(PB—86-242856/XAB) US EPA workshop to develop a simple model for acid deposition. Final report.** Jeffries, H.E. (North Carolina Univ., Chapel Hill (USA). Dept. of Environmental Sciences and Engineering). Jul 1986. 57p. NTIS, PC A04/MF A01.

The Acid Deposition Planning Staff in the Office of Acid Deposition/EPA requested that the Atmospheric Sciences Research Laboratory undertake the development of a low-computational-demanding model suitable for educational use in understanding the linear or nonlinear nature of the acid-deposition process and that could assist in constructing a what if analysis for a particular situation. In response, ASRL held a workshop, attended by EPA and non-EPA scientists, to discuss the design of such a model. In addition, a five-person working committee of non-EPA scientists was established to write a statement of work for the construction of such a model. The report summarizes the planning activities that occurred before the workshop, the two days of discussion held at the workshop, the three days of working committee meetings after the workshop, and includes the resulting Statement of Work for the creation of a Comprehensive Chemistry Acid Deposition Model (CCADM).

7345 **(PB—86-243292/XAB) Florida acid-deposition study. A literature review of the ecological and material effects of acid deposition.** Newman, J.R.; Fletcher, S.W.; Hendry, C.D.; Pollman, C.D.; Carter, L.C. (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Jan 1982. 278p. (ESE—81-631-600-008F). NTIS, PC A13/MF A01.

The ecological and material effects of acid deposition have been a point of concern in the U.S. because of conflicting information regarding the nature of these impacts, not only negative effects, but also positive effects. Phase I of the Ecological and Material Effects program was designed to initiate a better definition of the concern by evaluating the current literature regarding the ecological and material effects of acid deposition and its relevancy to Florida. Among the objectives accomplished by this program during Phase I were: (1) implementation of literature search and evaluations; and (2) identification of the limitations of various approaches to addressing the basic objectives, and assessment of these approaches in terms of their applicability to Florida. This report presents the results of the Phase I analysis.

7346 **(PB—86-243318/XAB) Florida acid-deposition study. Source attribution evaluation: Phase 1. Summary report.** (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Jan 1982. 60p. (ESE—80-610-119). NTIS, PC A04/MF A01.

Phase I initiated the four-phase study in January 1981 with the design, installation, and operation of a 14-station acid-deposition monitoring network during an 11-wk period (June, 1981 - September, 1981). The objective of the source-attribution program of the Florida-Acid Deposition Study is to determine the relative contribution of Florida's electric utility industry to the acidity of precipitation both in Florida, and beyond state boundaries. The program is a natural complement to the monitoring program. A review of the characteristics, applications, and limitations of techniques to determine source attribution are reviewed in the report. These techniques have included long-range transport (LRT) models, mass-balance models, trajectory analysis, sulfur-isotope analysis, dissolved-sulfur dioxide ($SO_2$) analysis, point-source studies, radar storm tracking, and satellite imagery.

7347 **(PB—86-243326/XAB) Florida acid-deposition study. Monitoring program. Phase 1. Summary report.** (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Jan 1982. 107p. (ESE—80-610-119F). NTIS, PC A06/MF A01.

In November 1980, the Florida Electric Power Coordinating Group, Inc. (FCG) Executive Committee approved the Florida Acid-Deposition Study. The Florida Acid-Deposition Study's overall objective is to assess and/or develop the information needed to place the acid deposition issue in the proper perspective as to its magnitude, variability, sources, effects, and control options in Florida. The first of four phases was initiated in January, 1981. The accomplishments of Phase I were: Design monitoring network; Develop and review network procedures; Acquire acid deposition monitoring equipment; Install monitoring network; Operate monitoring network (from July, 1981 through mid-September, 1981 - a predetermined time frame for initial testing of the monitoring network. Data collected was subsequently submitted for final analysis). Results from the various programs are summarized in the report.

7348 **(PB—86-243334/XAB) Florida acid-deposition study. Phase 4 report. Volume 1.** (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). 28 Jun 1985. 151p. (ESE—83-152-0602-0120-VOL-1). NTIS, PC A08/MF A01.

The Florida Acid-Deposition Study's overall objective is to assess and/or develop the information needed to place the acid-deposition issue in the proper perspective as to its magnitude, variability, sources, effects and control options in Florida. To meet this objective, two distinct but related atmospheric-transport techniques were initiated during Phase IV: long-range transport (LRT) modeling using the ENAMAP model and modified mass-balance analyses using the NOAA-ATAD model. Acid-deposition monitoring was continued during the period of Sept., 1983 to Sept., 1984 at seven sites across the state. Also, during Phase IV, the primary objective of the ecological effects program was to further the ability to assess response or sensitivity of aquatic and terrestrial resources within Florida to acidic deposition. The Phase IV studies represent an extension of Phase III work, as well as other studies initiated by the University of Florida within the Lake McCloud watershed.

7349 **(PB—86-243342/XAB) Florida acid-deposition study. Phase 4 report. Volume 2.** (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). 28 Jun 1985. 512p. (ESE—83-152-0602-0120-VOL-2). NTIS, PC A22/MF A01.

The overall objective of the Florida Acid-Deposition Study is to assess and/or develop the information needed on acid deposition as to its magnitude, variability, sources, effects, and control options in Florida. The last complete phase of the study, Phase IV, was initiated in September 1983 with all scientific work completed in January 1985. During this phase, work continued to focus on obtaining data and performing studies which, when combined with results of previous phases, would meet the overall objectives of the study. This Executive Summary briefly describes the results obtained during Phase IV in the three program areas: Acid Deposition Monitoring, Source Attribution, and Ecological Effects.

7350 **(PB—86-243359/XAB) Florida acid-deposition study. Final report: a synthesis of the Florida acid-deposition study.** (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Mar 1986. 737p. NTIS, PC A99/MF A01.

The study was implemented in four major phases, each phase investigating three major areas of research: acid-deposition monitoring, source attribution, and ecological effects. In the report, the information developed in all phases of the Study is analyzed within and across the three research areas to provide answers to key study questions. Acid-Deposition Monitoring: To provide precipitation and air chemistry data for the source attribution and ecological effects research areas. Source Attribution: To assess the contribution of the Florida electric utilities to current levels of acidity within Florida and in surrounding states using long range transport (LRT) and mass-balance models. Ecological effects: To assess the response and potential sensitivity of aquatic and terrestrial resources within Florida to acid deposition and the potential for effects on man-made material. A series of literature, process-oriented, direct-response experimental, and modeling studies was performed from January, 1981 through June, 1985.

7351 **(PB—86-243367/XAB) Florida acid-deposition study. Phase 3 report.** (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Aug 1984. 570p. (ESE—82-615-0600-2110). NTIS, PC A24/MF A01.

The Florida Acid-Deposition Study's overall objective is to assess and/or develop the information needed to place the acid-deposition issue in the proper perspective as to its magnitude, variability, sources, effects, and control options in Florida. Operation of the monitoring network was continued. Several special source attribution studies were also performed from September, 1982 through September, 1983 to continue the goal of assessing the contribution of the Florida utilities to the acid-deposition phenomenon within Florida and in neighboring states, i.e., (1) Development of NOx and SOx emission inventories; (2) Evaluation of the natural contribution to Florida's sulfur emission inventory; (3) Analysis of sulfur isotopes in precipitation at one site; and (4) Analysis of trajectory, precipitation, and meteorological data, and further investigation of atmospheric transport and deposition models. A pilot study to determine if organic acids could be detected in Florida's rainfall was performed during Phase III. Research was initiated in Phase III to gather data directly on specific processes affecting terrestrial and aquatic ecosystem responses to acidic deposition.

7352 **(PB—86-244860/XAB) Studies of dry acid deposition in the South Coast Air Basin: tunable diode laser absorption spectrometer measurements of $HNO_3$, HCHO and $NO_2$ and luminol $NO_2$ measurements in Claremont, California, September 1985. Final report, August 1985-July 1986.** Mackay, G.I.; Schiff, H.I.; Mayne, L.K.; Harris, G.W. (Unisearch Associates, Inc., Concord, Ontario (Canada)). Jul 1986. 146p. NTIS, PC A07/MF A01.

Two Tunable Diode Laser Absorption Spectrometer (TDLAS) systems were used to measure $HNO_3$. One system also measured formaldehyde (HCHO) atmosphere. Nitrogen dioxide ($NO_2$) was measured by the second TDLAS and by the LUMINOX, LMA-3 which is a new, small, simple and extremely sensitive instrument for $NO_2$ measurements. The importance of these measurements is the role that $NO_2$ plays as the direct precursor to gas phase $HNO_3$. Agreement between the $HNO_3$ measurements obtained by the 2 TDLAS systems were within the combined experimental errors. The diurnal behavior of the $HNO_3$ concentrations were quite regular with a maximum occuring between 15:00 and 18:00 each day. Maximum concentrations of 18 ppbv were observed on September 14th. HCHO exhibited similar behavior with the largest measured values of 14 ppbv occurring at 15:00 on the 13th. $NO_2$ showed somewhat more variable behaviour generally with two maxima, one in the afternoon and one about midnight. The TDLAS and LUMINOX were in good agreement with a few interesting exceptions.

7353 **(PB—86-244878/XAB) User's guide for POSTZ: a post-processor for the SHORTZ air-quality model. Final report.** Winges, K.D. (Kentucky Univ., Lexington (USA). Dept. of Geology). Jul 1986. 98p. (REPT—3481-R81). NTIS, PC A05/MF A01.

The report provides instructions for the use of the POSTZ computer program, a post-processor for the SHORTZ air-quality model. The POSTZ program is designed to read a sequential output tape of concentrations produced by the SHORTZ model. The POSTZ program provides summary tables of the highest concentrations for different averaging times. The POSTZ program allows the user to restrict the analysis to specific receptors, sources, or periods of meteorological data. In addition, the user can scale the concentrations from a particular source if desired. The user can select between running or block averages, and can implement the EPA CALMS policy if desired. The output tables can be in the form of the highest five concentrations for each receptor, the top 50 concentrations for all receptors, or all concentrations computed to be above a user-specified criteria value.

7354 **(PB—86-245248/XAB) Guideline on air quality models (revised).** (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Jul 1986. 267p. (EPA—450/2-78/027R). NTIS, PC A12/MF A01.

This guideline recommends air-quality modeling techniques that may be applied to air-pollution-control strategy evaluations and new source reviews, including prevention of significant deterioration. It is intended for use by EPA Regional Offices in judging the adequacy of modeling analyses performed by EPA, by State and local agencies, and by industry and its consultants. It also identifies modeling techniques and data bases that EPA considers acceptable. The guideline makes specific recommendations concerning air-quality models, data bases, and general requirements for concentration estimates.

7355 **(PB—86-246287/XAB) Metabolic activation and DNA adducts of dinitropyrenes. Research report, 1 January 1984-31 December 1985.** Beland, F.A. (Arkansas Univ. for Medical Sciences, Little Rock (USA). Dept. of Biochemistry). 1986. 41p. NTIS, PC A03/MF A01.

The study explored the sequence of reactions through which nitrated pyrenes, important mutagenic and potentially carcinogenic components of diesel exhaust, are converted metabolically within bacterial and mammalian cells into reactive forms that damage DNA. Results indicate that (1) factors in addition to nitroreduction were involved in the metabolic activation of dinitropyrene, (2) differences exist among the nitropyrene compounds tested in the mechanism of nitroreduction, (3) reduction to 1-nitrosopyrene is the limiting step in the metabolic activation of 1-nitropyrene, while subsequent esterification of the reduced intermediates is critical for the activation of the dinitropyrenes, (4) the extent of DNA binding of the different compounds was correlated with the extent of their nitroreduction, and (5) anaerobic intestinal microflora play an important role in metabolizing orally administered nitropyrenes.

7356 **(PB—86-246949/XAB) Industrial-hygiene walk-through survey report of Dow Chemical, USA Allyn's Point Plant, Gales Ferry, Connecticut.** Roberts, D.R.; Krishnan, E.R. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). May 1986. 33p. (IWS—147.36). NTIS, PC A03/MF A01.

The purpose of the survey was to obtain information on the SB latex production process and assess the potential for occupational exposure to 1,3-butadiene. The information will be used in determining the suitability of inclusion of the facility in an in-depth survey regarding the substance. The Allyn's Point Plant employs 164 people; 33 work in the SB latex area where 1,3-butadiene is used. The weighted mean 8-hour time-weighted average for 93 samples was 0.25 ppm. The results of the NIOSH analysis of bulk samples of SB latex were nondetectable. The level of detection was 0.04 ng/mg by weight. Based on a review of historical industrial-hygiene data provided by Dow showing detectable 1,3-butadiene exposures for two job classifications, it is the decision of NIOSH to include Dow as a candidate for an in-depth industrial hygiene survey.

7357 **(PB—86-247301/XAB) Review of improved mobile source exposure estimation. Special report.** Richardson, B.C.; Joksch, H.C. (Richardson Associates, Inc., Ann Arbor, MI (USA)). Jun 1986. 44p. (RAI—86-103). NTIS, PC A03/MF A01.

Improved Mobile Source Exposure Estimation presents the National Exposure Model (NEM) as modified for mobile sources. The objective of the modified model is to estimate nationwide, annual person hours of exposure to any mobile source pollutant. Data on population activity in various neighborhood types, emissions factors, and pollutant concentrations are used as input in calculating exposure distributions. Data on population and pollution detailed enough to forecast person hours of exposure to pollutants in a rigorous and straightforward manner are not available. Therefore, the model authors had to work with limited data and make many strong assumptions. Because of the scarcity of data, the reliability of the model results cannot be assessed.

7358 **A method for the removal of sulfur dioxide from exhaust gas utilizing pulsed streamer corona for electron energization.** Mizuno, A.; Clements, J.S.; Davis, R.H. (Dept. of Physics, Florida State Univ., Tallahassee, FL 32306). *IEEE (Institue of Electrical and Electronics Engineers) Transactions on Industry Applications;* IA-22: No. 3, 516-522(May 1986).

The performance of a new method using pulsed streamer corona for the removal of SO/sub 2/ from humid air has been evaluated. The pulsed streamer corona produces energetic free electrons that excite, dissociate, and ionize gas molecules, forming radicals that enhance the gas-phase chemical reactions that convert SO/sub 2/ to acid mist and/or particulate aerosols. The aerosols are then collected by conventional means, i.e., by electrostatic precipitator or bag filter. The SO/sub 2/ removal efficiency was compared with that of the electron-beam and dc corona flue-gas treatment processes. The comparison demonstrates the advantage of the novel method.

7359 **Atmospheric tracer technology and applications.** Heiken, J.H. Park Ridge, NJ; Noyes Publications (1986). 368p. Noyes Publications, Mill Road at Grand Avenue, Park Ridge, NJ 07656.

This book presents information on atmospheric tracer technology and applications. It summarizes the state of the art, provides information exchange for members of the atmospheric community, defines areas for future applications of tracers, and identifies requirements for tracer techniques. A major objective of research in atmospheric science over the past several decades has been to obtain an enhanced description of transport, transformation, and deposition of trace constituents present in the atmosphere. Interest in these processes has been hightened with the recognition that pollutant materials transported over long distances may exert significant effects at receptor locations, and the consequent desire to improve knowledge of source-receptor relationships. There is a wide range of practical applications for tracer experiments. In many cases the tracer allows 1) the documentation of a potential airborne hazard without actually emitting hazardous material or 2) the evaluation of the expected outcome of an expensive process alteration. Some examples of the former case are testing of rocket fuels, developing chemical defense strategies, establishing safety procedures for possible accidents in the handling and transportation of hazardous materials, and assessing the fire and explosion hazards present in handling special materials such as liquified natural gas. The practical use of tracers for economic benefit includes designing emissions systems, for both air quality control and dissemination systems such as in forest and crop spraying or cloud seeding, and siting of industrial facilities. Other applications include source attribution, which is currently of interest in the acid rain problem.

7360 **Catalytic activity of shock modified ZnO for CO oxidation and methanol synthesis.** Williams, F.L.; Graham, R.A.; Lee, Y.K.; Morosin, B. (Univ. of New Mexico, Albuquerque, NM). pp 791-796 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

This paper reports steady-state rate measurements of CO oxidation and methanol synthesis over shock compressed ZnO powders under reaction conditions believed to be transport limitation free. The reactions were followed by conventional gas chromatography. The rate of CO oxidation is enhanced by shock compression of ZnO, and the rate of methanol synthesis is enhanced by shock compression of ZnO. The rate of reaction for each of the major species formed is shown as a function of peak shock pressure.

## 5003 Radioactive Materials Monitoring And Transport

*REFER ALSO TO CITATION(S) 6574, 6704, 6739, 7411*

7361 (INIS-mf—10308) **30 years of monitoring environmental radioactivity in the Federal Republic of Germany.** (Bundesministerium des Innern, Bonn (Germany, F.R.)). 1985. 153p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

The individual sections of the report describe the development of monitoring functions and of the contamination of the atmosphere and the biosphere by radioactive substances. After environmental radioactivity due to the fallout of nuclear explosions reached a peak level in 1963, its contribution to radiation exposure today is insignificant in comparison with natural radioactivity. Moreover, monitoring by authorities of the emissions and the environmental impact of nuclear installations has been extended during the past 20 years in such a way that the existing network of measuring stations takes full account of the increased number of nuclear installations. The monitoring results show that nuclear installations do not make any considerable contribution to environmental radioactivity.

7362 (INIS-mf—10308, pp 2-11) **History of environmental radioactivity monitoring.** Fischer, A. (Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe, Germany, F.R. Zentrallaboratorium fuer Isotopentechnik). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

With the EURATOM treaty gaining legal validity in the law of the FRG in 1958, the Federal Republic of Germany accepted the obligation of regularly monitoring the environmental radioactivity. Measuring stations have been established in the FRG in the years 1960 and 1961, and a system of coordinated monitoring and evaluation has been set up. This network has been completed by a nuclear installations surveying system, KFUe, and by an additional system of monitoring stations in border regions. The measuring stations in the various Federal Lands together with governmental supervisory and coordinating boards, today form a system that reliably detects environmental radioactivity.

7363 (INIS-mf—10308, pp 12-25) **Air and deposition.** Kiesewetter, W. (Deutscher Wetterdienst - Zentralamt, Offenbach am Main, Germany, F.R.). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

The Deutscher Wetterdienst (German Weather Service) was given the task in 1961 to act as the directing centre for air and deposition monitoring in the FRG, which primarily meant fallout and atmospheric radioactivity monitoring over the territory of the FRG. In addition, the Bundesamt fuer Zivilschutz (Federal Office for Civil Defence) since 1960 specialized in measuring and monitoring the fission product Kr-85 in the atmosphere. The interlaboratory comparisons and analyses made every year for various radionuclides guarantee early detection of changes in the level of airborne environmental radioactivity.

7364 (INIS-mf—10308, pp 116-124) **Gaseous effluents.** Haubelt, R.; Winkelmann, I. (Bundesgesundheitsamt, Neuherberg, Germany, F.R. Inst. fuer Strahlenhygiene). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

The main tasks of the gaseous wastes monitoring programme are gammaspectroscopy measurements of selected aerosol and iodine filter specimens from vent air monitoring systems in the stacks of nuclear power stations, alphaspectrometry analyses, and determination of Sr-89/Sr-90 activity in aerosol filter samples. Further tasks include measurements for the determination of tritium activity in gaseous effluents, integral and nuclide-specific comparative analyses of radioactive noble gases in vent air, and measurements for calibrating noble gas monitors in nuclear power plant stacks. The paper illustrates monitoring results by the example of a table showing the annual release from nuclear power stations of radioactive noble gases and aerosols, of I-131, $CO_2$-bound C-14, and tritium. Annual averaged results for noble gases today are below $3.7 \cdot 10^{13}$ Bq (1000 Ci), for long-life aerosols and for I-131 below $3.7 \cdot 10^{9}$ Bq (0.1 Ci), for $^{14}CO_2$ below $3.7 \cdot 10^{11}$ Bq (10 Ci), and for tritium below $3.7 \cdot 10^{12}$ Bq (100 Ci).

7365 (INIS-mf—10308, pp 141-142) **Remote monitoring of nuclear power stations.** Edelhaeuser, H. 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

By 1983, the regional governments of the Federal German Lands where nuclear power stations were operating or under construction had given their consent to establishing a remote monitoring network. By now, remote monitoring systems are already in operation in some of these Lands, others are being installed or planned. The operating results obtained so far in general have met with the approval of the various regional governments, although there have been problems in the starting phase which for the most part were of a technical nature.

7366 (SCPRI-RM—12-1985) **Monthly results of measurements, December 1985, with supplement related to the three months, October, November, December 1985.** (Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France)). Jan 1986. 49p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE87750280.

Measurement tables concerning the surveillance of the environment in France with supplement related to the three months, October, November, December 1985.

7367 (STL-A—48, pp 7-8) **Radionuclides in ground-level air. Chapter 1.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

In the air surveillance programme the concentrations of artificial radionuclides were monitored in the air close to the ground to obtain the necessary basic data for estimating the exposure of the Finnish population to fall-out radionuclides, and also to detect atmospheric traces of radioactive materials caused by their use or production. Airborne dust was collected on filters with high-volume air samples, and the concentration of gamma-emitting radionuclides and strontium were evaluated in air. The main source of long-lived radionuclides detected in 1983 was the stratospheric inventory built up by earlier, high-yield, atmospheric nuclear explosions. In some occurrences short-lived, fresh radioactive debris was also observed. The concentrations of radionuclides measured in ground level air were very low in 1983.

7368 (STL-A—48, pp 121-124) **Measurements of environmental gamma radiation. Chapter 8.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

The total gamma radiation exposure rates measured in 1983 around the nuclear power stations in Finland are reported. The results show no reactor-caused changes. The measurements made using a Ge(Li) spectrometer in the direction of the gaseous effluent plume of the Loviisa 1 reactor show a very low $^{41}Ar$ contribution. No other effluent nuclides were observed.

7369 (STL-A—48, pp 125-128) **Summary and discussion. Chapter 9.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

In this chapter we shall assess the overall impact of fall-out from nuclear explosions and releases from the nuclear power industry and give summaries of the effective dose equivalents.

7370 **(STL-A—48) Studies on environmental radioactivity in Finland 1983. Annual report.** (Institute of Radiation Protection, Helsinki (Finland)). Feb 1984. vp. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

Separate abstracts and indexing were prepared for individual chapters.

7371 (UCRL—50007-85, pp 49-53) **HOT SPOT Health Physics codes.** Homann, S.G. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

The newly developed HOT SPOT Health Physics codes allow fast assessment of accidents involving radioactive materials. These codes run on the Hewlett-Packard HP-41 family of handheld computers, and the software resides on a single 128K minicassette. This compact system is intended for easy field use of the HOT SPOT codes. At present, 13 separate programs exist, ranging from general programs for downwind assessment following the release of radioactive material to more specific programs dealing with the release of plutonium, uranium, or tritium. Other programs estimate the dose commitment from the inhalation of various radionuclides, and estimate the effects of a surface-burst nuclear weapon.

7372 **Radon and radon progeny in 70 houses in the Tennessee Valley area: study design and measurement methods.** Dudney, C.S.; Hawthorne, A.R.; Monar, K.P.; Quillen, J.L.; Clark, C. Jr.; Doane, R.W.; Wallace, R.G.; Reed, R.P. (Oak Ridge National Lab., TN). pp 70-77 of Indoor radon. Pittsburgh, PA; Air Pollution Control Association (1986). (CONF-860277—). Contract AC05-84OR21400.

From APCA specialty conference on indoor radon; Philadelphia, PA, USA (24 Feb 1986).

Levels of radon and its short-lived airborne progeny are being measured in a year-long study of 70 houses in four states in the Tennessee Valley. Various methods were used to solicit volunteers with differing degrees of success. Criteria for selection of houses in the study included presence of a lower level with cement floor and one or more block walls in contact with the soil, absence of obvious indications of technologically enhanced sources of radium, and proximity to one of four cities, (Knoxville, Chattanooga, Birmingham, or Florence). By design, most houses in the study are in the same neighborhood as at least one other house in the study. Houses range in age from newly constructed to about 40 years old. Most of the houses have more than 2000 square feet of finished floor space. The lower level encompasses a garage in most cases. More complete information pertaining to house characteristics will be gathered in the course of the study. Measurements are being made to obtain information on both location- and season-dependent variation of radon and radon progeny. Simultaneous measurements are made quarterly on both upper and lower levels of each house. Grab samples of air are collected and analyzed for radon using a modified Lucas cell technique. Short-term (10-minute) samples of airborne particulate material are collected and analyzed for radon progeny. One-week integrated measurements of working levels are made once each quarter using modified thermoluminescent dosimeters. Both three- and twelve-month integrated measurements of radon using track-etch monitors are being made. 19 references, 1 figures.

# 51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

## 5101 Basic Studies

*REFER ALSO TO CITATION(S) 6765, 6766, 7509, 7510, 7511, 7512, 7513, 7514, 7515*

7373 **(DOE/EV/00641—54) Mineral cycling in soil and litter arthropod food chains. Three-year progress report, February 1, 1984-January 31, 1987.** Crossley, D.A. Jr. (Georgia Univ., Athens (USA). Dept. of Entomology). 29 Aug 1986. Contract AS09-76EV00641. 85p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87002342.

This report summarizes progress in a three-year research project on the influence of soil arthropods (mites, collembolans, insects, millipedes and others) upon decomposition rates and nutrient dynamics in decaying vegetable matter. Research has concentrated on two aspects of elemental dynamics in decomposing organic matter: Effects of arthropods on rates of decomposition and nutrient loss (mineralization of carbon and other elements), and arthropod stimulation of microbial immobilization of nutrient elements during decomposition.

7374 **(DOE/EV/00641—T1) Diurnal activity of soil surface arthropods in agroecosystems: design for an inexpensive time-sorting pitfall trap.** Blumberg, A.Y.; Crossley, D.A. Jr. (Georgia Univ., Athens (USA)). 1986. Contract AS09-76EV00641. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002343.

The design for an inexpensive time-sorting pitfall trap is presented. The basis of the mechanism is a rotary stepping solenoid powered by lantern batteries. Traps were utilized to sample soil surface arthropods at two hour intervals for five 24 hr periods in 1983. One trap each was placed in conventional tillage (CT) and no-tillage (NT) agroecosystems. Soil arthropod surface activity was greatest in CT on 9 July during the dawn and dusk periods but the data did not indicate other dominant trends. Activity in NT was greatest during dusk on 27 June, but again no other dominant trends were evident. When CT and NT are combined over the sample dates, surface soil arthropod activity peaked during dusk, with a smaller activity peak at dawn. 10 refs., 6 figs.

7375 **(ORNL/TM—9712) Forest succession in the Upper Rio Negro of Colombia and Venezuela.** Saldarriaga, J.G.; West, D.C.; Tharp, M.L. (Oak Ridge National Lab., TN (USA)). Nov 1986. Contract AC05-84OR21400. 173p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87002330.

Woody vegetation from 23 forest stands along the Upper Rio Negro of Venezuela and Colombia was sampled in 1982 to examine the hypothesis that the Amazon forest has been largely undisturbed since the Pleistocene, to quantify vegetation development during different stages of succession following agricultural development, and to determine the time required for a successional stand to become a mature forest. The ubiquitousness of charcoal in the tierra firme forest indicated the presence of fire associated with extreme dry periods and human disturbances. Changes in species composition, vegetation structure, and woody biomass were studied on 19 abandoned farms and four mature forest stands. Living and dead biomass for the tress and their components was determined by regression equations developed from measurements of harvested trees. The rate of recovery of floristic composition, structure, and biomass following disturbance is relatively slow. Aboveground dead biomass remained high 14 years after the forest was disturbed by the agricultural practices. The lowest dead biomass is reached 20 years after abandonment, and the largest values are found in mature forests. Data analysis of 80-year-old stands showed that the species composition approached that of a mature forest. Approximately 140 to 200 years was required for an abandoned farm to attain the basal area and biomass values comparable to those of a mature forest. The results of this study indicate that recovery is five to seven times longer in the Upper Rio Negro than it is in other tropical areas in South America.

## 5102 Chemicals Monitoring And Transport

*REFER ALSO TO CITATION(S) 6763, 6765, 6766, 7279*

7376 **(PB—86-246261/XAB) Selected compilation of unpublished graduate theses: titles, abstracts, and reviews from Florida universities relating to marine and coastal environmental studies. Final report.** Jones, J.I.; Rigby, E.; Jordan, B.; Smith, A.M.; Starnes, E.M. (Florida Div. of State Planning, Tallahassee (USA). Office of the Director). Jun 1975. 225p. (DSP-DO—27-75). NTIS, PC A10/MF A01.

With the advent of petroleum exploration activities on the Florida continental shelf, it became apparent that identification, review, and compilation of the maximum possible environmental information relative to the marine environments of the Florida coastal zone, territorial sea, and adjacent continental-shelf waters would be essential. Categories of theses and dissertations included are: biology, geology, chemistry, physical oceanography, and miscellaneous studies. Dates of theses and dissertations included are 1950 to 1973.

7377 **Dissolution of iron sulfates from pyritic coal waste.** Sullivan, P.J.; Mattigod, S.V.; Sobek, A.A. (Univ. of Wyoming Research Corp., Laramie). *Environmental Science and Technology;* **20**: No. 10, 1013-1016(Oct 1986). Contract AC02-84ER60202.

A pyritic coal waste was leached under saturated conditions for 6 months. Waste samples were removed after 3 and 6 months of leaching. These samples, in addition to a sample with no leaching, were used to make up equilibrium solutions. The leaching data showed a continuous release of iron and sulfate species and low acidity under anaerobic conditions. As leaching progressed, the relatively soluble phases were removed, leaving the control of activities to less soluble primary and secondary mineral. Data from the equilibrium solutions were used to calculate the saturation index for common secondary minerals that could form in the waste/water system. The saturation index data show that (1) the common iron mineral phases under anaerobic and acid conditions will continually dissolve, (2) halotrichite may be controlling the activities of Fe(II), Al, and $SO_4$, and (3) illite may limit the activities of Mg, K, and Si. These data indicate that changes in the solid phase with leaching will change the long-term geochemistry of the waste/water system. 17 references, 1 figure, 4 tables.

## 5103 Radioactive Materials Monitoring And Transport

*REFER ALSO TO CITATION(S) 6510, 6573, 6574, 6740, 7361, 7362, 7366, 7369, 7370*

7378 (INIS-mf—10308, pp 58-63) **Soil and ground cover.** Wiechen, A.; Heine, K. (Bundesanstalt fuer Milchforschung, Kiel, Germany, F.R. Inst. fuer Chemie; Bundesanstalt fuer Milchforschung, Kiel, Germany, F.R. Inst. fuer Physik). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

The monitoring programmes set up in accordance with the directives for the surveillance of effluents from nuclear installations oblige operators of such installations to take samples of vegetation (grass) and soil twice a year at the least favourable place in the industrial plant's environment, and at a reference site, for radioactivity monitoring by gamma spectroscopy. In addition, the samples are to be examined for their Sr-90 content. Data recorded over the years show that nuclear facilities do not significantly contribute to soil and vegetation contamination with Sr-90 or Cs-137. The directives require regular interlaboratory comparisons, which are coordinated by the directing centre at Kiel.

7379 (INIS-mf—10308, pp 92-99) **Milk and dairy products.** Wiechen, A.; Heine, K. (Bundesanstalt fuer Milchforschung, Kiel, Germany, F.R. Inst. fuer Chemie; Bundesanstalt fuer Milchforschung, Kiel, Germany, F.R. Inst. fuer Physik). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

Gammaspectroscopic measurements are taken as an example to describe the monitoring programme of the FRG for monitoring of milk and dairy products. A table shows the number of milk samples taken every year in the FRG in the general environment, and in the vicinity of nuclear installations, together with the radioactivity data obtained by gammaspectroscopy. Due to the decreasing radioactivity as a result of the nuclear weapons tests fallout, the number of samples taken in the general environment has been cut down to half over the period under review. The monitoring capacity set free by this decision has been used during this period for enhanced monitoring of milk and dairy products in regions where nuclear installations such as nuclear power plants have been operating. The nuclides of interest are Sr-90, Cs-137, J-131.

7380 (INIS-mf—10308, pp 100-110) **Specific foodstuffs and food in general.** Frindik, O.; Fischer, E. (Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe, Germany, F.R. Zentrallaboratorium fuer Isotopentechnik). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

The radioactivity data measured in food primarily prepared in establishments for communal provisions allow an overall assessment of the radiation exposure of the population, as the radioactivity levels of specific foodstuffs by this procedure can be evaluated in correlation with the real amount of food ingested. Results of the monitoring campaigns in the past have shown that there is no need for separate monitoring of foodstuffs produced in the vicinity of nuclear installations, as comparisons have shown that in general, there were no differences detectable. Nuclear technology is said to be no factor of special importance contributing to radioactivity in foodstuffs, the main source of contamination still being the fallout of nuclear weapons tests, particularly with regard to Cs-137 and Sr-90. Natural radionuclides, however, such as uranium and thorium and their decay products, are attracting more attention in food monitoring.

7381 (STL-A—48, pp 35-46) **Milk. Chapter 3.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

Finnish milk was analysed for the long-lived fallout radionuclides $^{90}Sr$ and $^{137}Cs$ in 1983. The nationwide mean concentrations were 0.13 Bq/l or 0.11 $Bq(gCa)^{-1}$ for $^{90}Sr$ and 0.35 Bq/l or 0.22 $Bq(gK)^{-1}$ for $^{137}Cs$. In 1983 the internal dose commitment for the average consumption of milk was 6 μSv (0.15 mrem) from $^{137}Cs$ to the whole body. The monthly results for the milk samples from the vicinities of the nuclear power stations at Loviisa and Olkiluoto are given. No fallout radionuclides with short or medium half-life were found in milk samples in 1983.

7382 (STL-A—48, pp 49-67) **Foodstuffs other than milk. Chapter 4.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

Analyses were carried out to determine the radioactivity in various foodstuffs in 1983, both nationwide and regionally around the nuclear power stations at Loviisa and Olkiluoto. Foodstuff samples were analysed for $^{89}Sr$ and $^{90}Sr$ as well as $^{137}Cs$ and other gamma-emitting nuclides. The levels of $^{90}Sr$ and $^{137}Cs$ in agricultural products and fish varied in the region of those of 1982. No fresh fallout was detectable in foodstuff samples in 1983. The dietary intake of $^{90}Sr$ and $^{137}Cs$ by adult Finns was 0.2 Bq $^{90}Sr/d$ and 0.7 Bq $^{137}Cs/d$. The dose equivalent commitments from annual ingestion were 10 μSv from $^{90}Sr$ to bone marrow and 3 μSv from $^{137}Cs$ to the whole body.

7383 (STL-A—48, pp 113-120) **Man. Chapter 7.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

In order to monitor changes in radioactivity levels in the Finnish population, whole-body counter measurements were made on three different control groups in 1983. The groups were from the Helsinki area and from the areas around the Loviisa and Olkiluoto nuclear power stations. The Helsinki group was measured with a scanning type, four-crystal whole-body counter in an iron room. The Loviisa and Olkiluoto groups were measured with a mobile, shadow-shield whole-body counter. Only $^{40}K$ and small amounts of $^{137}Cs$ activities were detected. The mean value of the $^{137}Cs/K$ ratio of the Helsinki control group in December 1983 was 0.74 Bq/kg, the corresponding values for the Loviisa and Olkiluoto groups being 0.40 Bq/kg and 0.56 Bq/kg, respectively.

# 52 ENVIRONMENTAL SCIENCES, AQUATIC

## 5201 Basic Studies

7384 **(DOE/EV/10259—T3) Geographic analysis of thermal equilibria: A bioenergetic model for predicting thermal response of aquatic insect communities: Progress report.** Vannote, R.L.; Sweeney, W. (Academy of Natural Sciences, Avondale, PA (USA). Stroud Water Research Center). 12 Nov 1986. Contract AC02-79EV10259. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002529.

Vannote and Sweeney have presented a general hypothesis concerning the influence of temperature on the growth and development of aquatic insects. The hypothesis predicts that the size and fecundity of adult insects should vary with latitude, being greatest near the center of a species' geographic range, and diminishing near the northern and southern limits of the range. They further suggested that the predicted austral and boreal diminution is associated with a reduction in fitness that ultimately determines the geographic limits of the species. This report presents a test of Vannote and Sweeney's central prediction of geographic variation in size of aquatic insects. The analysis is based on collections of aquatic insects from streams and rivers ranging from first through eight-order along a latitudinal gradient ranging from South Carolina to Quebec in eastern North America. The analysis is based on 29 species of mayflies and stoneflies taken from a total of 54 sites. All species are univoltine at most of the study sites and emerge from late winter through midsummer. We show that among the assemblage of species taken as a whole, the hypothesis that maximum size occurs near the center of a species' range is supported. There is, however, also a significant tendency for insects to exhibit either monotonic increases or monotonic decreases in size along a latitudinal gradient. 13 refs., 6 figs., 4 tabs.

7385 **(PB—86-245776/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 1. Executive summary. Final report.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 96p. NTIS, PC A05/MF A01.

See also Volume 2, PB—86-245784, and PB—84-113273; Also available in set of 7 reports PCE99, PB—86-245768.

The study describes the benthic communities and habitats off southwest Florida from Florida Bay northward to Charlotte Harbor and in depths from 20m to 200m. Both live and soft bottom regions were sampled using conventional trawls, dredges and grabs. Habitat descriptions were made along six transects using underwater televisions, still cameras side-scan-sonar, and shallow subbottom profilers. Sediments were analyzed for total organic carbon, carbonate, grain size, hydrocarbons, and trace metals. Water column descriptions included dissolved oxygen, salinity, temperature measures; photometer and transmissivity profiling; and analyses of nutrients, chlorophyll, and yellow substance. No major increases were observed seasonally and the shelf waters are considered oligotrophic. Only one station exhibited petroleum-like hydrocarbons. Trace metals were found to be distributed at very low levels uniformly throughout the area.

7386 **(PB—86-245784/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 2. Final report 1.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 279p. NTIS, PC A13/MF A01.

See also Volume 1, PB—86-245776, Volume 3, PB—86-245792, and PB—84-113331; Color illustrations reproduced in black and white; Also available in set of 7 reports PC E99, PB—86-245768.

The final report characterizes major distinguishable types of substrates and biotic communities on the southwest Florida Shelf. It reviews all sampling and analytical methods and the regional hydrography and sediment chemistry. The Southwest Florida Shelf Ecosystems Study was undertaken to describe the benthic communities and habitats off southwest Florida from Florida Bay northward to Charlotte Harbor and in depths from 20 to 200m. Both live and soft bottom regions were sampled using conventional trawls, dredges, and grabs. Habitat descriptions were made along six transects using underwater televisions, still cameras, side-scan-sonar, and shallow subbottom profilers. Sediments were analysed for total organic carbon, carbonate, grain size, hydrocarbons, and trace metals. Water column descriptions included dissolved oxygen, salinity, temperature measures; photometer and transmissivity profiling; and analyses of nutrients, chlorophyll, and yellow substance. Only one station exhibited petroleum-like hydrocarbons. Trace metals were found to be distributed at very low levels uniformly throughout the area.

7387 **(PB—86-245792/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 3. Final report 2.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 413p. NTIS, PC A18/MF A01.

See also Volume 2, PB—86-245784, Volume 4, PB—86-245800, and PB—84-113281; Also available in set of 7 reports PC E99, PB—86-245768.

The report presents a biological characterization of the southwest Florida shelf, describing shelfwide zonation and biotic distribution patterns, taxonomic composition, seasonality, and relationships between communities and substrate type. The study was undertaken to describe the benthic communities and habitats off southwest Florida from Florida Bay northward to Charlotte Harbor and in depths from 20m to 200m. Both live and soft-bottom regions were sampled using conventional trawls, dredges, and grabs. Habitat descriptions were made along six transects using underwater televisions, still cameras side-scan-sonar, and shallow subbottom profilers. Six live and soft-bottom substrate types were distinguished, five of which were supportive of sessile live-bottom communities. Live bottom habitats and communities were quite patchy in spatial distribution.

7388 **(PB—86-245800/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 4. Final report 3.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 253p. NTIS, PC A12/MF A01.

See also Volume 3, PB—86-245792, and Volume 5, PB—86-245818; Also available in set of 7 reports PC E99, PB—86-245768.

The report, summarizes findings on the physical environment and biota of this region, and reviews potential OCS development impacts. It reviews oil and gas activities, possible pathways for ecological change and special regional concerns (e.g. biologically sensitive areas).

7389 **(PB—86-245818/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 5. Appendix A. Final report.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 483p. NTIS, PC A21/MF A01.

See also Volume 4, PB—86-245800, and Volume 6, PB—86-245826; Also available in set of 7 reports PC E99, PB—86-245768.

The report, (Appendix A) presents cruise logs, stations sampling data, and hydrographic and sedimentary data.

7390 **(PB—86-245826/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 6. Appendix B. Final report.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 408p. NTIS, PC A18/MF A01.

See also Volume 5, PB—86-245818, and Volume 7, PB—86-245834; Also available in set of 7 reports PC E99, PB—86-245768.

The final report (Appendix B) presents the master National Oceanographic Data Center taxon code list as well as the raw data for soft-bottom trawl and box core biotic collections.

7301 **(PB—86-245834/XAB) Southwest Florida Shelf ecosystems study - Year 2. Volume 7. Appendix C. Final report.** (Woodward-Clyde Consultants, Walnut Creek, CA (USA)). Jul 1985. 328p. NTIS, PC A15/MF A01.

See also Volume 6, PB—86-245826, and PB—84-113307; Also available in set of 7 reports PC E99, PB—86-245768.

The final report (Appendix C) provides computer listings of live-bottom station data, including other trawl, triangle dredge and quantitative slide analysis.

7302 **(PB—86-246147/XAB) Southwest Florida Shelf regional biological communities survey, marine habitat atlas. Volume 2. An addendum and update of the Southwest Florida Shelf ecosystems study - Years 1 and 2 marine habitat atlas.** (Continental Shelf Associates, Inc., Tequesta, FL (USA)). Jul 1985. 54p. NTIS, PC A04/MF A01.

See also PB—86-245834; color illustrations reproduced in black and white.

The survey was developed to describe the benthic communities and habitats off southwest Florida, from Florida Bay northward to Charlotte Harbor, and in depths from 20 to 200m. A portion of the descriptive work was based on tows of underwater television, still camera, side scan sonar, and shallow subbottom profiling systems across the shelf. The Year III report updates a previous report from Years I and II. It describes six (6) visually identifiable habitats and ten (10) identifiable community types, one not seen previously. The narrative report accompanies a large-format Atlas (Volume 1, not available through NTIS).

7303 **(PB—86-246311/XAB) Southwest Florida Shelf benthic communities study, Year 4 annual report. Volume 1. Executive summary.** Danek, L.J.; Lewbel, G.S.; Tomlinson, M.S.; Boland, G.S.; Tourtellotte, G.H. (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Jul 1985. 55p. (REPT—83-513-0561-VOL-1). NTIS, PC A04/MF A01.

See also Volume 2, PB—86-246329; Also available in set of 3 reports PC E99, PB—86-246303.

The report is a summary of results of one year of field studies on the southwest Florida shelf. The effort was designed to continue descriptive biological and habitat investigations conducted during Years I-III. Environmental monitoring arrays were deployed on five selected stations each representing an identifiable live bottom type. These were equipped with fouling plates, current meters, and sediment traps. Two were additionally fitted with time-lapse cameras and wave gages. Five shallow, soft-bottom station benthic communities were primarily infaunal, highly diverse, and had a high species richness and evenness. Of 10 live-bottom stations, six in the inner-shelf region were very similar. The remaining four, located in the Middle/Outer Shelf region were generally dissimilar reflecting differences in suspended solids, sediment characteristics, sediment transport, wave action, currents, and variations in temperature and salinity. Wave action and currents at the shallowest station were very active in resuspending and transporting sediments.

7304 **(PB—86-246329/XAB) Southwest Florida Shelf benthic communities study, Year 4 annual report. Volume 2. Technical discussion.** Danek, L.J.; Lewbel, G.S.; Tomlinson, M.S.; Boland, G.S.; Tourtellotte, G.H. (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Jul 1985. 285p. (REPT—83-513-0561-VOL-2). NTIS, PC A13/MF A01.

See also Volume 1, PB—86-246311 and Volume 3, PB—86-246337; Also available in set of 3 reports PC E99, PB—86-246303.

The fourth-year study was designed to continue descriptive biological and habitat investigations conducted during Years I-III. Environmental-monitoring arrays were deployed on five selected stations each representing an identifiable live bottom type. These were equipped with fouling plates, current meters, and sediment traps. Two were additionally fitted with time lapse cameras and wave gages. Five shallow, soft-bottom station benthic communities were primarily infaunal, highly diverse, and had a high species richness and evenness. Of 10 live-bottom stations, six in the inner-shelf region were very similar. Wave action and currents at the shallowest station were very active in resuspending and transporting sediments. The sediment traps at the shallowest station indicated an average of up to 1,000 metric tons per square kilometer per day were resuspended to a height of 0.5 meter (m) during the most active winter months. The shallowest station exhibited much faster plate recruitment than deeper stations.

7305 **(PB—86-246337/XAB) Southwest Florida Shelf benthic communities study, Year 4 annual report. Volume 3. Appendices.** Danek, L.J.; Lewbel, G.S.; Tomlinson, M.S.; Boland, G.S.; Tourtellotte, G.H. (Environmental Science and Engineering, Inc., Gainesville, FL (USA)). Jul 1985. 470p. (REPT—83-513-0561-VOL-3). NTIS, PC A20/MF A01.

See also Volume 2, PB—86-246329; Also available in set of 3 reports PC E99, PB—86-246303.

The appendix (Volume 3) accompanies the Technical Discussion (Volume 2) of the study. It presents station plots, physical oceanography data, ancillary physical data, sediment data, lists of infauna, epifauna, nekton and macroalgae, and fouling-plate data.

7306 **(PB—86-246345/XAB) Northern Gulf of Mexico Contintental Slope Study. Executive Summary (Year 1). Report for 30 September 1983-28 February 1985.** (LGL Ecological Research Associates, Inc., Bryan, TX (USA)). May 1985. 23p. NTIS, PC A02/MF A01.

The study prepared for the Minerals Management Service summarizes the Year I Annual report which details the findings of one-year sampling on the continental slope of the Gulf of Mexico. Results of two cruises are presented with information concerning field and laboratory methods and procedures for identifying organisms.

7307 **(PB—86-246352/XAB) Northern Gulf of Mexico Continental Slope Study. Annual report (Year 1). Report for 30 September 1983-28 February 1985.** (LGL Ecological Research Associates, Inc., Bryan, TX (USA)). May 1985. 312p. NTIS, PC A14/MF A01.

The report includes the sampling results of two cruises, which are presented with information concerning field and laboratory methods and procedures for identifying organisms. A general overview of the physical and chemical processes in the Gulf of Mexico is presented along with preliminary findings concerning the high-molecular-weight hydrocarbons in sediments and organisms. Sediment texture, organic carbon, and carbonate and carbon isotope analysis are discussed. The biological oceanographic section discusses macroepifauna, fish, meiofauna and macroinfauna including an analyses of zonation patterns in these organisms and comparison of species diversity with previously recorded results.

7308 **Growth and production of a stream stonefly: influences of diet and temperature.** Sweeney, B.W.; Vannote, R.L. (Stroud Water Research Center of the Academy of Natural Sciences of Philadelphia, Avondale, PA). *Ecology;* 67: No. 5, 1396-1410(Oct 1986). Contract AC02-79EV10259.

The natural influx of leaf litter from a hardwood forest to sections of two spring seeps and a spring brook was excluded for two years and replaced with equivalent amounts of leaves from specific tree species. Larval growth, mortality, and productivity, as well as the timing of emergence and the size of adults, were assessed in the naturally occurring populations of Soyedina carolinensis, and the differences related to differences in available food and in temperature among study sites. During the first experimental year, larvae fed only on sugar maple or chestnut oak leaves exhibited the same rate and magnitude of growth as larvae fed the natural mix of leaves collected from the surrounding forest. Larval growth rates and adult size seemed lower on monospecific diets of hickory, American beech, and red oak leaves relative to the natural, mixed leaf diets. Adult emergence occurred on or about the same date for most diets. Larval production ranged from 1382 to 5500 mg x $m^{-2}$ x $yr^{-1}$; there was no correlation between larval growth rate and

productivity on a given diet. During the second experimental year, most sites that had been supplied with single-species leaf diets during the first experimental year were provided with sugar maple leaves only. This was an attempt to evaluate site-to-site differences in habitat quality (other than diet) that might affect the growth performance of larvae. The amount of variation in larval growth rate and adult size among sites having a common diet was equal to or greater than among-site variation during the previous year, when each site differed in leaf diet. In the spring brook experiment, both diet and location within the brook exerted significant effects on larval growth rate and adult size.

## 5202 Chemicals Monitoring And Transport

*REFER ALSO TO CITATION(S) 6763, 6765, 6766, 6933, 7345, 7350, 7351, 7376*

7399 **(AD-A—171579/6/XAB) Installation-restoration program. Phase II. Confirmation/quantification. Stage 1. Homestead Air Force Base, Florida. Final report, August 1984-March 1986.** Spooner, P.A.; Vickers, B.C. (Science Applications International Corp., McLean, VA (USA)). 7 Mar 1986. 229p. NTIS, PC A11/MF A01.

A total of 13 sites at Homestead Air Force Base (AFB) were identified by the Phase I Installation Assessment as having a potential for environmental contamination. These 13 sites were ranked using the Hazardous Assessment Rating Methodology (HARM) and the top eight ranked sites were recommended for monitoring under Phase II. Two additional sites, from the original 13 sites, the leak at Pump Station No. 9 (SP-5) and the Residual Pesticide Disposal Area (P-3), were added by USAFOEHL to the Phase I recommendations for monitoring making a total of 10 sites that received Phase II confirmation investigation. Two sites (SP-4 and SP-6), located near the west gate, in close proximity to one another, are indistinguishable from each other based on the groundwater analysis results. these are combined into a single zone for Phase II, Stage 2 recommendations. Nineteen 2-inch groundwater monitoring wells were installed into the upper Biscayne aquifer during Phase II, Stages. These, along with three existing wells, were sampled, with samples being shipped to both OEHL and SAIC laboratories. Soil samples were collected at three sites, and sediment samples at two.

7400 **(Juel-Spez—349) Contributions to environmental specimen banking. Pt. 2. Decomposition and stability studies of methylmercury in water.** Ahmed, R.; Stoeppler, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Angewandte Physikalische Chemie). Mar 1986. 55p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87750079.

Long-term stability of $Hg^{+2}$ and MeHgCl, and decomposition of MeHgCl under different conditions are investigated. Studies were done with acids and sodium hydroxide with and without adding different reagents at room temperature and higher temperatures with and without UV-light. The results show that in the absence of light MeHgCl does not decompose to $Hg^{+2}$ even in the presence of 25% acids. MeHgCl is also not easily decomposed by heating in the presence of low acid concentrations. But with UV-light decomposition of MeHgCl to $Hg^{+2}$ takes place immediately depending upon the intensity of UV-light. In the presence of SH-groups (L-cystein) partial stability and complexation of mercury was observed.

7401 **(PB—86-246253/XAB) Results from the chemical analysis of oily residue samples taken from stranded juvenile sea turtles collected from Padre and Mustang Islands, Texas. Special report (Final).** Overton, E.B.; Byrne, C.J.; McFall, J.A.; Antoine, S.R.; Laseter, J.L. (New Orleans Univ., LA (USA). Center for Bio-Organic Studies). Dec 1983. 32p. NTIS, PC A03/MF A01.

Juvenile Kemp's Ridley sea turtles were released June 7, 1983 off the Texas coast by the National Marine Fisheries Service, as part of an U.S. - Mexico cooperative effort to augment the natural breeding stock of the endangered species. Between one and six days later many dead or distressed Kemp's Ridleys were found stranded on Padre and Mustang Islands with oily residues in the mouth and esophagus. Six samples were analyzed for Ni/V content API gravity, stable C, H, and S isotopes, and hydrocarbon composition with high-resolution gas chromatography and HRGC-mass spectrometry. Results were: (1) oils came from multiple sources, (2) composition was predominantly in the n-C20 to n-C32 range (waxy paraffins), (3) residues were most probably from discarded tanker cleaning operations.

7402 **Influence of habitat manipulations on interactions between cutthroat trout and invertebrate drift.** Wilzbach, M.A.; Cummins, K.W.; Hall, J.D. (Univ. of Maryland, Frostburg). *Ecology;* 67: No. 4, 898-911(Aug 1986).

The objectives of this study were to examine the interactions of the riparian setting (logged vs forested) and prey availability on the prey capture efficiency and growth of cutthroat trout, and to determine if the riparian setting influences the impact of trout predation on drift composition. Short-term relative growth rates of cutthroat trout, experimentally confined in stream pools, were greater in a logged than in a forested section of stream. Differences in growth rates were attributed to differences, among pools in invertebrate drift density, and to differences in trout foraging efficiency that were related to differences between the sections in the amount of overhead shading and substrate crevices. Mean percentages of introduced prey captured by trout were greater in logged control pools and pools of both sections whose bottoms were covered with fiberglass screening to eliminate substrate crevices than in forested control pools and logged pools that were artificially shaded. A logarithmic relationship was found between trout foraging efficiency and surface light of pools. Drift density significantly increased relative to controls in pools from which trout were removed in the logged reach, but not in the forested section. This may result from habitat features in the logged section that favor greater trout foraging success and the occurrence of behaviorally drifting prey taxa, which represent a predictable food supply for the trout.

7403 **Simulation of solute transport in a chemically reactive heterogeneous system: model development and application.** Miller, C.W.; Benson, L.V. (Lawrence Berkeley Lab., CA). *Water Resources Research;* 19: No. 2, 381-391(Apr 1983). Contract AC03-76SF00098.

One-dimensional transport of solutes in a saturated porous medium has been simulated using a numerical model CHEMTRN. This model includes dispersion/diffusion, advection, ion exchange, formation of complexes in the aqueous phase, and the dissociation of water. The mass action, transport, and site constraint equations are expressed in a differential/algebraic form and solved simultaneously. In the mass action equations describing complexation and sorption processes, the activities of the species in the aqueous phase are approximated using the Davies equation. A solubility constraint can be set at the inner boundary. The model was applied to a study of the migration of strontium in groundwater. Results show that surface site competition is important when the strontium concentration is comparable to the background electrolyte concentration, in which case a constant k/sub D/ model does not simulate the transport of chemical species adequately. In addition, the pH level was buffered to a level of approximately 10 near the wasteform due to the incorporation of the solubility constraint. For the particular case studied, the incorporation of aqueous complexation did not significantly enhance strontium mobility. 24 references, 8 figures, 1 table.

## 5203 Radioactive Materials Monitoring And Transport

*REFER ALSO TO CITATION(S) 6510, 7361, 7362, 7366, 7369, 7370, 7480*

7404 (INIS-mf—10308, pp 26-36) **Surface water, particulate matter, and sediments of inland waters.** Mundschenk, H. (Bundesanstalt fuer Gewaesserkunde, Koblenz, Germany, F.R.). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

The Bundesanstalt fuer Gewaesserkunde (BfG) since 1958 runs a system for monitoring the surface water and sediments of

7412 (STL-A—48, pp 69-87) **Surface water. Chapter 5.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

Monitoring of radioactivity in fresh water and sea water was continued during 1983. The results of $^{90}Sr$, $^{90}Sr$, $^{3}H$, $^{239,240}Pu$, $^{241}Am$ and gamma radionuclide determinations reported in this chapter are either from nationwide survey programmes or from monitoring programmes in the vicinities of the Loviisa and Olkiluoto nuclear power stations. The $^{90}Sr$, $^{137}Cs$ and $^{3}H$ levels in fresh water and sea water have decreased slightly or remained at roughly the same level as in the previous year. The $^{239,240}Pu$ and $^{241}Am$ concentrations in sea water near the nuclear power stations were roughly the same as in previous years. Concentrations in the open sea were about the same as in the coastal areas. $^{90}Sr$ was found once in sea water in 1983. Some activation products were detected twice in sea water near the nuclear station of Olkiluoto.

7413 (STL-A—48, pp 89-111) **Sediments and aquatic indicators. Chapter 6.** Feb 1984. NTIS (US Sales Only), PC A07/MF A01. File Number DE87780029.

In Studies on environmental radioactivity in Finland 1983. Annual report.

Determinations of $^{90}Sr$, certain gamma nuclides and $^{239,240}Pu$ in sedimenting material, bottom sediment and biota in the Baltic Sea area and near the Loviisa and Olkiluoto nuclear power stations were continued in 1983. Special sediment surveys were carried out in 1982 at Loviisa and in 1983 at Olkiluoto. In sedimenting material and biota the concentrations of long-lived radionuclides were roughly the same as in 1982. The amounts of activation products were slightly higher than in 1982 in sedimenting material, bottom animals and littoral algae sampled in sea areas near the Loviisa and Olkiluoto power stations. In Loviisa some fission products released from the nuclear power station were also detected. In the bottom sediments of the Loviisa and Olkiluoto sea areas the total amounts of $^{90}Sr$ (77-310 $Bqm^{-2}$), $^{137}Cs$ (2000-7800 $Bqm^{-2}$) and $^{239,240}Pu$ (86-240 $Bqm^{-2}$) were roughly the same as in 1975-1980. In the deep basin sediments of the Baltic Sea area, the total $^{90}Sr$, $^{137}Cs$ and $^{239,240}Pu$ ranges were 48-83 $Bqm^{-2}$, 220-2700 $Bqm^{-2}$ and 16-170 $Bqm^{-2}$, respectively.

# 53 ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

## 5302 Assessment Of Energy Technologies

7414 (ORNL/M—243) **[Public comments on OSTP coordinated framework for regulation of biotechnology].** Colwell, R.K. (California Univ., Berkeley (USA). Dept. of Zoology). 24 Sep 1986. Contract AC05-84OR21400;AC03-76SF00098. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002289.

A study was made of the June 26, 1986, Federal Register notice concerning the Coordinated Framework for Regulation of Biotechnology (51 FR 23301-23350), and of the Department of Agriculture's accompanying Advanced Notice of Proposed Guidelines for Biotechnology Research (51 FR 23351-23393). This letter describes this study and responds to the request for public comment on those documents. While we endorse the goal of developing criteria to distinguish proposals unlikely to present an unreasonable risk from those involving a greater number of risk factors, we have serious concerns about certain aspects of the criteria proposed in the June 26 Federal Register for the a priori assignment of proposals to abbreviated review or exemption from review. In the report, these concerns are described, and in each case an offer is made of practical and constructive modifications of the basic regulatory outline proposed by the BSCC and the Agencies involved.

# 55 BIOMEDICAL SCIENCES, BASIC STUDIES

## 5502 Biochemistry

7415 (DOE/ER/10637—T1) **Bioenergetics of salt tolerance. Final report.** Packer, L. (California Univ., Berkeley (USA). Dept. of Physiology-Anatomy). 28 Oct 1986. Contract AS03-80ER10637. 27p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87002309.

Major findings are presented on how Synechococcus responds to a transition from low salt (12mM NaCl) to high salt (0.5 M NaCl) medium; we have studied immediate and long-term osmotic responses, identified deleterious effects of NaCl on cellular processes, and analyzed adaptations of the bioenergetic systems that permit the organism to tolerate a high salt environment. We have also developed new electron spin resonance methods for measuring intracellular $O_2$ concentrations and intracellular pH. In addition studies on the physiology and molecular mechanism of light-driven chloride transport by halorhodopsin in the halobacteria are reported. The ion-transport ATPase of halobacteria and the respiration-linked sodium transport system of the halotolerant bacterium, Bal were studied with respect to the role and functioning of ionic pumps. Chloride transport was shown to be an integral componet of the overall ion circulation in halobacterial cells, one which maintains internal salt concentration and therefore cellular volume. How halorhodopsin functions, its photointermediates, the nature of chloride-binding sites, the role of the deprotonation of the retinal Schiff-base, and how removal of most of the arginine residues, does not affect chloride-binding are reported. Methods were developed for the study of membrane-bound halobacterial ATPase, its solubilization and partial purification. 43 refs., 1 fig.

7416 (DOE/EV/04330—1) **Development of new fluorescent markers for chromosome study. Progress report, May 1, 1984-April 30, 1985.** Vogelbacker, H. (Pennsylvania Univ., Philadelphia (USA). Hospital). Jul 1985. Contract AC02-77EV04330. 15p. NTIS, PC A02. File Number DE87002276.

Potential fluorescent markers for chromosomes were synthesized and evaluated for interaction with DNA. A fluorescent analog of ATP, a fluorescent ribonucleic acid probe, and an analog of the fluorescent dye DAPI have been synthesized and tested. Flow analysis of chromosomes from a number of different human cell lines was successful. 10 figs.

7417 **EXAFS studies of binuclear iron complexes as models for hemerythrin and related proteins.** Hedman, B.; Co, M.S.; Armstrong, W.H.; Hodgson, K.O.; Lippard, S.J. (Stanford Synchrotron Radiation Lab., CA). *Inorganic Chemistry;* **25:** No. 20, 3708-3711(24 Sep 1986).

There is increasing interest in oxo-bridged polyiron centers in biology. Binuclear units of this kind occur in hemerythrin, the marine invertebrate oxygen carrier, in ribonucleotide reductase, and in purple acid phosphatases. The reversible binding of dioxygen in hemerythrin has been postulated to occur where the bridging carboxylate groups are contributed from glutamate and aspartate residues of the protein. Following the synthesis of realistic model compounds for both oxidized and reduced forms of the hemerythrin iron core, as well as analogues of the former in which either the oxo bridge was protonated or the bridging carboxylate ligands were replaced by diphenylphosphate groups, they have been working to establish their relevance to the chemical and physical properties of the proteins. Previously, they showed close similarities between the molecular geometry, magnetic exchange interactions, and optical spectroscopic and vibrational properties of azidomethemerythrin and the model compounds $[Fe_2O(O_2CCH_3)_2(HB(pz)_3)_2]$ and $[Fe_2O(O_2CCH_3)_2(TACN)_2]^{2+}$, where $HB(pz)_3^-$ = hydrotris(1-pyrazolyl)borate and TACN = 1,4,7-triazacyclononane. They now report the results of extended X-ray absorption fine structure (EXAFS) studies of these two complexes as well as the derivatives $[Fe_2O(O_2P(OC_6H_5)_2)_2(HB(pz)_3)_2]$ and $[Fe_2(OH)(O_2CCH_3)_2(HB(pz)_3)_2]^+$. This work addresses in well-defined model systems how sensitive EXAFS spectroscopy is to the important question of

modulations in the iron-to-bridging oxygen and nonbonded, e.g. Fe...Fe or Fe...P, distances. Such geometric information is necessary to understand the oxygen binding reaction of hemerythrin as well as the structural biology of ribonucleotide reductase and purple acid phosphatase.

7418 **Studies of vitamin E binding and transfer by a rat liver cytosolic protein.** Posch, K.C.; Mavis, R.D. (Univ. of Rochester, NY). *Federation Proceedings, Federation of American Societies for Experimental Biology;* **45**: No. 6, 1673(May 1986). (CONF-8606151—). Contract FG02-85ER60282.

From 76. annual meeting of the Federation of American Society for Experimental Biology; Washington, DC, USA (8 Jun 1986).

In vitro vitamin E binding and transfer were examined using a semipurified (sephadex G-75 fraction) vitamin E binding and transfer protein (VE-TBP) from the rat liver cytosol. Binding and transfer studies thus far indicate that the protein is very specific for d-α-tocopherol. Among the other lipophilic ligands examined only d-γ-tocopherol at high concentrations was competitive with d-α-tocopherol binding. Specificity studies also indicate the protein to be stereospecific in nature since dl-α-tocopherol was only partially competitive. Studies using PMSF and NEM also indicate that neither a hydroxyl nor a sulfhydryl functional group on the protein is required for vitamin E binding. Transfer studies show that the VE-TBP is capable of specifically transferring equal amounts of vitamin E from liposomes to both mitochondria and microsomes when comparable protein concentrations are used. This indicates that no preferential transfer to one membrane type occurs. Pretreatment of mitochondria and microsomes with heat, pronase or trypsin also does not affect transfer of vitamin E. Thus, transfer of vitamin E is not dependent on a membrane protein. Finally, the VE-TBP is capable of unidirectional transport of vitamin E from prelabelled microsomes to vitamin E free liposomes.

7419 **Summary of discussion: models and technology used in positron emission tomography.** Wolf, A.P.; Budinger, T.F. (Brookhaven National Lab., Upton, NY). *Annals of Neurology;* **15**: No. 4, S44-S45(Apr 1984).

The discussion reported herein centered around three points: (1) multicomponent models relating to actual physiological models, (2) ability of positron emission tomographic (PET) devices to provide data adequate for the applications of these models, and (3) instrumental aspects of PET in order to achieve higher resolution. In order to formulate models, it was pointed out that it must be known what process in what disease is to be modeled. The approach should be to formulate a hypothesis that can be tested with appropriate PET technology, development of appropriate radiopharmaceuticals and meaningful models that will yield the parameters that can provide answers to the proposed questions. Models have been developed for physiological transport of glucose and understanding neuroreceptor ligands.

## 5503 Cytology

7420 (UCRL—50007-85, pp 19-23) **Assessment and characterization of aerosols generated from a dual-beam high-speed flow cytometer.** Kwan, J. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Since material processed through a flow cytometer may include various mutagenic chemicals and pathogenic microorganisms, the potential for aerosolization of this material and subsequent personnel exposure are issues of concern. To assess and characterize the aerosol-generation potential of a dual-beam high-speed flow cytometer, a test solution ($10^8$ particles/ml of lambda phages in a buffer solution) was processed through the cytometer. Aerosolized particles were then captured by an Anderson air sampler on agar plates seeded with Escherichia coli. It was found that this flow cytometer did indeed generate significant amounts of aerosolized particles in the respirable range. Further work needs to be done to determine the effectiveness of an enclosure surrounding the cytometer to trap such aerosols.

## 5504 Genetics

*REFER ALSO TO CITATION(S) 7414, 7416*

## 5505 Metabolism

7421 (DOE/EV/00119—261, pp 71-76) **Skeletal changes during pregnancy and lactation.** Miller, S.C.; Bowman, B.M.; Redd, E.H.; Shupe, J.G.; Miller, M.A.; Omura, T.H.; Smith, L.J. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

There are changes in maternal mineral metabolism during pregnancy to accommodate fetal skeletal development and during lactation for milk production. Intestinal absorption of calcium, and other elements, increases during pregnancy and mineral is accumulated in the skeleton. During lactation there is a decreased bone mass with accelerated bone turnover in many species. The purpose of this study was to determine changes in bone mineral content, cortical and trabecular bone morphometry, and bone formation rates during pregnancy and lactation in rats. The most striking observation made in this study was the increase in bone formation parameters during pregnancy. These increases observed at mid-pregnancy are consistent with the previous observations of increased endochondral growth and dentin apposition at this same time. The increase in bone formation parameters would account for the increases in bone weights and calcium content during pregnancy. During lactation there was decreased cortical and trabecular bone mass due to endosteal resorption. This was accompanied by increased endosteal bone formation parameters, indicating that this is a high-turnover type of bone loss. Accelerated bone turnover during lactation in rats has also been suggested from isotopic studies.

## 5506 Medicine

*REFER ALSO TO CITATION(S) 6915, 6957*

7422 **(BNL—38571) Synchrotron radiation and biomedical imaging.** Luccio, A. (Brookhaven National Lab., Upton, NY (USA). National Synchrotron Light Source Dept.). Aug 1986. Contract AC02-76CH00016. 32p. (CONF-860787—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001370.

From Advances in medical imaging and related dosimetry conference; Erice, Sicily, Italy (5 Jul 1986).

In this lecture we describe the characteristics of Synchrotron radiation as a source of X rays. We discuss the properties of SR arc sources, wigglers, undulators and the use of backscattering of laser light. Applications to angiography, X ray microscopy and tomography are reviewed. 16 refs., 23 figs.

7423 **(FRNC-TH—2283) Inhomogeneities in high energy photon beams used in radiotherapy. Experimental and theoretical studies.** Kappas, K. (Toulouse-3 Univ., 31 (France)). Jan 1986. 259p. (In French). NTIS (US Sales Only), PC A12/MF A01. File Number DE87750035.

This work is dedicated to the influence of the human body inhomogeneities on the dose distribution for high energy photons beams used in Radiotherapy. It consists in an experimental part and a theoretical analysis leading to original models of calculation. We study essentially, - the beam quality of the machines used and its influence on some basic dosimetric quantities and on the response of an ionization chamber. - The dose perturbation due to off-axis heterogeneous volumes at off-axis points of measurement; a model is suggested to take into account the perturbation of the multiple scatter. The perturbation of the dose in the transition region, between water equivalent medium and heterogeneous medium (air) is also investigated. The last part is devoted to computer applications of the proposed correction methods and to a comparison between the different computerized treatment planning systems which take into account of inhomogeneities.

7424 **(HRP—0906956/8/XAB) Impact of the prospective payment system on the delivery of nuclear medicine services.** Crucitti, T.W.; Pappas, V.M. (Society of Nuclear Medicine, New York (USA). Technologist Section). Jul 1986. 10p. NTIS, PC A02/MF A01.

The study evaluates the effect of the Medicare Prospective Payment System (PPS) on nuclear medicine technologists and services. Since 80% of nuclear medicine technologists work in hospitals, a large segment of the professionals would be affected by the new system. The survey was designed to assess the PPSs effect on nuclear medicine departments at the early implementation stage.

7425 **Gamma-N activation of cancer patients.** Wielopolski, L.; Cohn, S.H.; Meek, A.G.; Moskowitz, M. (Med. Dept., Brookhaven National Laboratory, Upton, NY, USA; Rad. Oncol. Dept., University Hospital, SUNY, Stony Brook, NY, USA). pp 1431-1437 of Papers accepted for presentation at the 7. international conference MTAA. Pt. 2. Applications. Roskilde, Denmark; Risoe National Laboratory (1986). (CONF-8606127—).

From 7. international conference on modern trends in activation analysis; Copenhagen, Denmark (23 Jun 1986).

High energy gamma radiation (8 to 30 MeV) is gaining acceptance for radiation therapy of patients with deep cancers. This radiation is of sufficient energy to induce photonuclear activation of the elements in the human body. Our results of measurements of nitrogen and phosphorus in an anthropmorphic phantom, a cadaver, and a cancer patient with bremsstrahlung radiation from 15 MeV electrons demonstrate the feasibility of a method to monitor these two elements in the human body in vivo by measuring the radioactivity induced in these targets by photonuclear reactions.

## 5507 Microbiology

*REFER ALSO TO CITATION(S) 7415, 7508*

7426 **(DOE/ER/13125—T1) Bioextraction of iron from iron oxides. Final report, August 15, 1983-August 14, 1986.** Arnold, R.G.; DiChristina, T.J.; Hoffmann, M.R. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Environmental Engineering Science). 1986. Contract AS03-83ER13125. 207p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87002208.

The feasibilities of (1) liberating free energy from dissimilative iron reduction and (2) coupling oxidative phosphorylation to electron transport to Fe(III) are sensitive to the aqueous chemistry of Fe(III). A systematic investigation of iron-reduction kinetics as a function of Fe(III) speciation indicated that in Pseudomonas sp. 200 (1) iron-reduction rate is functionally related to the concentrations of individual iron species and (2) direct contact between Fe(III) and the ferrireductase of Pseudomonas sp. 200 is required for electron transfer. When Fe(III) is provided as an iron oxide, overall reduction rate is much slower, though still dependent upon provision of an Fe(III)-complexing ligand. Again, direct contact between oxide surface and microorganism is requisite to iron reduction. In Pseudomonas sp. 200 there are both a constitutive and an inducible pathway for electron transport to Fe(III). The species is able to maximize development of useable chemical energy from respiration by regulating both the synthesis of ferrireductase and the direction of electron transfer when alternative (branched) pathways are present. 218 refs., 80 figs., 32 tabs.

## 5509 Pathology

7427 **Nonenzymatic glucosylation of neuronal calmodulin and its functional consequences.** Kowluru, R.A.; Kowluru, A.; Bitensky, M.W. (Los Alamos National Lab., NM). *Federation Proceedings, Federation of American Societies for Experimental Biology;* **45**: No. 6, 1693(May 1986). (CONF-8606151—).

From 76. annual meeting of the Federation of American Society for Experimental Biology; Washington, DC, USA (8 Jun 1986).

Glucosylation (NEG) (nonenzymatic) of proteins is a post-translational protein modification that occurs readily in the diabetic environment. As a consequence of NEG some proteins are known to undergo a change in function. Their studies of red blood cell (RBC) cytoskeletal proteins indicate that calmodulin is glucosylated in the diabetic RBC and this is followed by a change in function. Here they present new data in support of their earlier findings. Purified bovine brain calmodulin was glucosylated in vitro in the presence of 28 mM glucose. After six days of incubation at room temperature 2.75 moles of glucose were incorporated per mole of calmodulin. Glucosylated calmodulin exhibited a marked reduction in calcium dependent functions. Its ability to stimulate neuronal phosphodiesterase (PDE) and adenylate cyclase was reduced by 65 and 80% respectively. Its ability to stimulate rat brain protein kinase was reduced by 40%. Glucosylated calmodulin exhibited a 56% drop in its $^{45}Ca$ binding as compared with unmodified calmodulin. These data provide an additional example in which NEG markedly alters protein function.

## 5520 Public Health

*REFER ALSO TO CITATION(S) 6759, 6761, 7279, 7325, 7327, 7328, 7330, 7331, 7332, 7333, 7356*

7428 **(PB—86-242724/XAB) Industrial-hygiene walk-through survey report of Dow Chemical, U.S.A. Allyn's Point Plant, Gales Ferry, Connecticut.** Roberts, D.R.; Krishnan, E.R. (National Inst. for Occupational Safety and Health, Cincinnati, OH (USA)). May 1986. 24p. (IWS—147.36). NTIS, PC A02/MF A01.

A walkthrough industrial hygiene survey of the Dow Chemical Compay Allyn's Point styrene butadiene (SB) latex-producing facility in Gales Ferry, Connecticut, was performed. Bulk polymer samples were analyzed for free-monomer emanation at ambient, highest polymer process, and highest estimated end use temperatures. Quality-control testing included purity and dimer content of incoming 1,3-butadiene and residual 1,3-butadiene content of the latex. Of 164 workers, 20 production and 13 administrative personnel worked in the SB area where 1,3-butadiene was used. Personal monitoring conducted from 1975 to 1985 showed the mean 8-hour time-weighted average exposure was 0.25 parts per million (ppm). Area monitoring showed the highest concentration, 0.56 ppm, in a reactor and a stripper area. SB latex at ambient, process, and end-use temperatures showed free monomer to be below the 0.04 nanograms per milligram limit of detection. The authors conclude that this production facility is a candidate for inclusion in an in-depth exposure survey regarding 1.3-butadiene.

## 5530 Agriculture And Food Technology

*REFER ALSO TO CITATION(S) 6765, 6766, 7414*

7429 **TPCI: A tool for commodity irradiation research.** Sloan, D.P.; Ahlstrom, S.B. (CH2M HILL, 6121 Indian School Road, N.E., Suite 206, Albuquerque, NM 87110). pp 266-275 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Although irradiation research for meeting quarantine objectives has been ongoing for many years, a strong need still exists for a mobile research irradiation unit that can be located onsite with the appropriate industry. Such an irradiator would facilitate the research needed before irradiation can be approved and accepted by regulatory agencies as a treatment for commodities subject to infestation by pests of quarantine importance. As part of the Byproducts Utilization Program, the U.S. Department of Energy is funding the development of a TransPortable Cesium Irradiator (TPCI). The irradiator is scheduled to be available by early 1985. This paper summarizes the operational characteristics and design considerations that are key to the development of TPCI and presents information important to researchers interested in utilizing the facility.

7430 **Radiation disinfestation of food and agricultural products.** Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). 419p. (CONF-8311102—). University of Hawaii at Manoa, Honolulu, HI 96822.

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

This book presents the papers given at a conference on the radiodisinfestation of food and crops. Topics considered at the conference included food irradiation's impact of the US Agency for International Development, FDA regulations, irradiation as a quarantine treatment, quality attributes of irradiated fruits, low-dose irradiation, cesium 137 as a radiation source, radiosterilization, economic feasibility, marketing, consumer acceptance, and the packaging of irradiated products.

7431 **The U.S. Department of Energy Program in low-dose food irradiation.** Krenz, D.L.; McMullen, W.H. (U.S. Dept. of Energy, Albuquerque Operations Office, P.O. Box 5400, Albuquerque, NM 87115). pp 25-38 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The U.S. Department of Energy's Byproducts Utilization Program (BUP) seeks to develop and encourage the widespread beneficial commercial use of waste byproducts produced by Department of Energy (DOE) programs. These byproducts are generally radioactive to varying degrees and consist of fission products resulting from irradiation of nuclear reactor fuel for production of special nuclear material at DOE facilities in Richland, Washington, and Savannah River, South Carolina.

7432 **Food irradiation's impact on the U.S. Agency for International Development's Postharvest Food Conservation Program.** Morris, R.F. (Agency for International Development, Office of Agriculture, Room 413A, SA-18, Washington, DC 20523). pp 39-44 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Developing countries frequently lack the storage, refrigeration, handling, and transportation systems required to efficiently market harvested crops. Postharvest losses are higher in lesser developed countries (LDC) but have been estimated at overall levels of 20 percent even in the United States. Food irradiation technology is one excellent example where developed and lesser developed countries can cooperate for mutual benefit. This technology is perhaps even more important to LDCs than it is for the developed world, where refrigerated cold chains and efficient marketing systems are in place and operating. For food irradiation to be economic, however, the technology must be applied on a large scale.

7433 **Radiation disinfestation: A viable technology for developing countries.** Loaharanu, P. (Food Preservation Section, Joint FAO/IAEA Div. of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna). pp 45-58 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Increasing food production in many countries is often offset by spoilage losses that occur at different stages after harvesting, slaughtering, or catching. The situation becomes critical in developing countries as more food is needed to feed the ever-increasing population. One of the major problems of losses of food and agricultural products during storage is insect infestation. This paper reviews some insect infestation problems of valuable crops in developing countries such as cereals, pulses, dried fish and meat, fresh and dried fruits, coffee and cocoa beans, spices, and cured tobacco leaves. Present practices of chemical fumigation to eliminate insect problems in these crops give rise to concern from the points of view of both public health and occupational safety. Irradiation technology has been shown to be as effective as other insect disinfestation methods and could provide a viable alternative for this purpose. Insects do not develop resistance to physical techniques such as heat or irradiation as they do to chemical treatments. Applications of radiation for disinfestation of food and agricultural products of importance to developing countries are discussed. The economics of radiation disinfestation of cereals and pulses, dried fish, and fresh fruits are also discussed.

7434 **FDA regulations for commercial food irradiation.** Takeguchi, C.A. (Div. of Food and Color Additives, Bureau of Foods, HFF-334, Food and Drug Administration, 200 C Street, SW, Washington, DC 20204). pp 59-62 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The Food and Drug Administration published an Advance Notice of Proposed Rulemaking (ANPR) on food irradiation on March 27, 1981 (FDA, 1981). The next step in the rulemaking process is a proposed rule that will deal with low-dose irradiation of certain foods and high-dose irradiation of spices. The status of the proposed regulation is discussed.

7435 **The potential of irradiation as a quarantine treatment for insects infesting stored-food commodities.** Brower, J.H.; Tilton, E.W. (Stored-Product Insects Research and Development Lab., ARS, USDA, Savannah, GA 31403). pp 75-86 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Recently, questions regarding the safety of chemical treatments for quarantine purposes have led to renewed interest in the use of radiation disinfestation as a quarantine treatment. Many species of stored-product pests are cosmopolitan, but other serious pests such as the khapra beetle (Trogoderma granarium), the larger grain borer (Prostephanus truncatus), and various species of legume weevils (Bruchidae) are not. Irradiation has been proposed as a possible quarantine treatment for various species of fruit flies, mango weevil, and codling moth but not for stored-product pests. However, irradiation has good potential for control of these pests, especially since the radiosensityvity of many of them is well documented. Irradiation is an approved method of direct control for stored-product insects in wheat and wheat four in many countries, and indications are that it will soon be approved for all grain, grain products, and other dry food commodities. Radiation doses required to kill or sterilize the most important storage pests in all stages are known, and these data can be used to calculate the required doses for quarantine treatments. Traditional quarantine treatments are designed to produce rapid mortality, but irradiation is only minimally effective in this regard. However, irradiation is very effective in preventing insect development and in producing sterility.

7436 **Disinfestation of wheat germ, wheat, and dried mushrooms by irradiation.** Kovacs, E.; Kiss, I.; Kuroli, G. (Central Food Research Institute, 1525 Budapest, Herman Otto u.15). pp 189-198 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The aim of the present study was to establish the dose requirement for disinfestation of different foods and to study their reinsfestation under different storage conditions such as temperature and packaging. Wheat germ, a new product in Hungary, has a storage life of only one month due to attack by insects and molds. An increase in the storage life of this product to 6 to 12 months was desired. The wheat germ was naturally infested by the flour beetle Tribolium confusum. Thereafter the samples were artificially infested by imagoes and larvae, irradiated at 0, 0.2, 0.4, 0.8, 1.6, 3.2, and 4.8 kGy with a Co-60 source, and stored at 20°C, 70-80 percent RH for 8 weeks. All imagoes in the samples treated with 1.6 kGy and above were killed immediately. With a treatment of 0.8 kGy all imagoes were dead 7 days after irradiation, and with 0.4 and 0.2

kGy doses all imagoes were dead 29 days after irradiation. After 8 weeks new generations in irradiated samples could not be found. In another experiment, samples were irradiated and stored at 5°C, 20°C, and ambient temperature. Different packaging materials, insects, molds, vitamins, tocopherols, lipids, and organoleptic properties (color, flavor, and taste) of different samples have also been studied.

7437 **Disinfestation of copra and coffee beans by gamma-radiation: Studies on population density, rearing, biology, and adult irradiation.** Manoto, E.C.; Blanco, L.R.; Resilva, S.S.; Carillo, P.V.; Casubha, L.C. (Philippine Atomic Energy Commission, Diliman, Quezon City). pp 199-206 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

This paper reports on the various studies conducted on some pests of copra and coffee beans in the Philippines with the ultimate goal of utilizing gamma-radiation for commodity treatment. Samples of copra collected from various warehouses in the three major islands yielded six species of beetles, one moth, one earwig, one psocid and three mites. The most prevalent among the pests in the copra beetle (CB), Necrobia rufipes De Geer. For the coffee bean weevil (CBW), Araecerus fasciculatus De Geer, robusta coffee was the least preferred as a host as compared with the other three commercial species. For rearing, the most efficient medium for CB was a combination of desiccated coconut + yeast (2:1); for CBW it was ground corn or copra pellet + wheat germ + yeast (5:3:1). Adult irradiation showed CBW to be more resistant than CB. A dose level of 0.50 to 0.75 kGy is needed for the control of CB and a dose level of 1.00 to 1.50 kGy for CBW.

7438 **Radiation disinfestation of dry fruits.** Khan, I.; Sattar, A.; Wahid, M.; Jan, M. (Nuclear Institute for Food and Agriculture, Tarnab, Peshawar). pp 207-213 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Dry fruits such as apricots, dates, figs, and raisins were irradiated in a Gamma Cell 220 (dose rate 0.04 kGy/min). Radiation doses used were 0.25, 0.50, and 1.00 kGy, and the samples were stored at room temperatures (25 to 40°C) after packaging in polyethylene pouches. Insect infestation and the changes in acidity, discoloration, ascorbic acid, and sugars were determined after 2,4,6,8,10, and 12 months. A radiation dose of 1.00 kGy completely inhibited infestation throughout the storage, while infestation in 0.50 and 0.25 kGy samples increased with storage time between 2 and 10 months. It was 100 percent in all fruits except raisins (60 percent) after 12 months. Tribolium species were predominant in all of the samples followed by the Caudra and Corcyra species. Discoloration increased, acidity and ascorbic acid contents decreased significantly ($P < 0.05$), and sugars were little affected during the entire storage. Radiation doses had insignificant influence on these nutrients except for the ascorbic acid, which was adversely affected, especially at higher doses ($P < 0.05$). Results of sensory evaluation of dried fruits showed 1.00 kGy treated samples rated as highest, 0.25 and 0.50 kGy as intermediates, and the control as lowest during different storage intervals.

7439 **Irradiation as a quarantine treatment for fruit subject to infestation by codling moth larvae.** Burditt, A.K.; Moffitt, H.R. (Research Entomologists, Agricultural Research Service, U.S. Dept. of Agriculture, 3706 W. Nob Hill Blvd., Yakima, WA 98902). pp 87-97 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The codling moth, Cydia pomonella (L.), is a pest of deciduous fruit throughout most of the world, except for Japan, Taiwan, Korea, and other limited areas. Its larvae infest apples, pear, walnuts, and many other deciduous fruit crops. Japan and Korea permit importation of cherries, a reported host, that have been fumigated using methyl bromide but prohibit importation of other host fruits from countries in which the codling moth is known to occur. The codling moth overwinters as diapausing larvae in cocoons. Research conducted at Yakima, Washington, has shown that nondiapausing codling moth larvae can be killed by methyl bromide fumigation at 32 g/m/sup 3/ for 2 hours at 20°C. This research has also shown that diapausing larvae are more resistant to methyl bromide than are nondiapausing larvae. Recently the Food and Drug Administration proposed approval of irradiation at a dose not exceeding 1 kGy as a treatment for commodities of quarantine importance that may be infested with insects. Exposure of immature insects to less than 1 kGy should prevent emergence of viable adults and would, therefore, be adequate to meet most quarantine restrictions. Research at Yakima to determine if irradiation can be considered as a potential quarantine treatment for codling moth larvae has shown that exposure of larvae at doses up to 100 Gy from a cobalt-60 gamma source will significantly reduce emergence of normal adults. Projecting these date, the authors estimated the dose required for quarantine security (99.9968 percent mortality), based on emergence of apparently normal adults from treated larvae, to be 145 Gy.

7440 **Gamma-radiation treatment for disinfestation of the medfly in thirty-five varieties of California-grown fruits.** Kaneshiro, K.Y.; Ohta, A.T.; Kurihara, J.S.; Kanegawa, K.M.; Nagamine, L.R. (Dept. of Entomology, Univ. of Hawaii, 3050 Maile Way, Honolulu, HI 96822). pp 98-110 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Minimum absorbed dosages of gamma-radiation required to prevent egg hatch and eclosion of adults when fruits infested with mature larvae are treated with gamma-radiation were determined. Studies were conducted with 35 varieties of California-grown fruits including 10 varieties of nectarines; 5 of plums; 4 of apples; 2 of pears; 4 of grapes, and 1 each of cherries, apricots, oranges, lemons, tomatoes, persimmons, and kiwifruits. Egg hatchability studies indicated that fruit condition, i.e., ripeness, water content, etc. at the time of treatment can effect the amount of radiation reaching the target organism. Thus, there may be considerable differences in the dose levels required to prevent hatch of medfly eggs in the different varieties of fruits. Nevertheless, despite the need for higher dosages in certain fruits, in all cases, none of the larvae that did hatch survived to develop beyond the first or second larval instar. Similar results were obtained in the larval survival studies. That is, mature larvae infesting different varieties of fruits required different dosages of radiation to prevent pupation and/or emergence as adults. Again, at the 0.5-0.6 kGy dosages, varying rates of pupation occurred depending on the variety of fruit. However, in all cases, none of the individuals survived to emerge as adults. The studies indicate that postharvest treatment with gamma-radiation is certainly a potential alternative to treatment with chemical fumigants such as EDB. More research should be conducted in this area with special emphasis on the condition of the fruit with respect to dosage/mortality determinations. Also, the studies on the Navel oranges indicate that combination treatments, in conjunction with gamma radiation can have a synergistic effect, and this aspect should certainly be investigated for all varieties of fruits.

7441 **Is the probit 9 security level appropriate for disinfestation using gamma-radiation.** Ohta, A.T.; Kaneshiro, K.Y.; Kurihara, J.S.; Kanegawa, K.M.; Nagamine, L.R. (Dept. of Entomology, Univ. of Hawaii at Manoa, 3050 Maile Way, Honolulu, HI 96822). pp 111-115 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The probit 9 concept requires that a given treatment result in 99.9968 percent mortality in an estimated population of 100,000 individuals. The USDA-Hawaiian Fruit Fly Investigations Laboratory has determined that 0.26 kGy is the minimum absorbed dose of

gamma-radiation required to prevent adult emergence of the three species of fruit flies in Hawaii: the Mediterranean fruit fly, Ceratitis capitata; the Oriental fruit fly, Dacus dorsalis; and the melon fly, Dacus cucurbitae. However, at dosages higher than 0.26 kGy, the authors observed relatively high rates of egg hatch (10-30 percent). In addition, when eggs are treated at 0.26 kGy, those larvae that do hatch may develop into third instar larvae, and their feeing may decrease the marketability of the fruits. Furthermore, there is some uncertainty as to whether or not importing countries would accept fruits with any living larvae in the shipment. For these reasons, the authors tried to determine the minimum absorbed dosages required to obtain mortality in mature eggs and larvae of the medfly. Results of the research showed that although high egg and larval mortality was observed at dosages of 0.50 to 0.60 kGy in nearly all of the fruit types and varieties studied, 100 percent mortality of mature eggs and larvae was not attained at these dosages. Nevertheless, the authors think that an increase in the minimum absorbed dose higher than that determined using the probit 9 concept (i.e., 0.26 kGy) should be considered because they were able to ascertain that, at dosages from 0.40 to 0.60 kGy, not only is egg hatch greatly reduced but the larvae hatching from these eggs developed only to the late first or early second larval instar stages.

7442 **Efficacy of gamma irradiation as a quarantine treatment against Queensland fruit fly.** Rigney, C.J.; Wills, P.A. (Gosford Horticultural Postharvest Lab., P.O. Box 355, Gosford, N.S.W.). pp 116-120 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Treatment of Queensland fruit fly, Dacus tryoni, eggs, and larvae with a dose of 75 Gy of radiation prevents the emergence of adult flies, although many insects develop to the pupal stage. This has been demonstrated with large numbers of insects present in oranges and avocados, two entirely different fruit types. The aim of such a commodity treatment should be to prevent the establishment of an insect pest in a new environment. This low-dose treatment should, therefore find acceptance with quarantine authorities, since the nonemergence of adult files effectively breaks the life cycle of the insect. This paper provides details of the experimental approach and the results of these efficacy studies.

7443 **Packaging-radiation disinfestation relationships.** Highland, H.A. (Agricultural Research Service, U.S. Dept. of Agriculture, Savannah, GA 31403). pp 369-373 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Foods that are susceptible to insect infestation can be irradiated to destroy the infestation; however, the food must be kept essentially insect-free until consumed, or it must be disinfested again, perhaps repeatedly. Insect-resistant packages can be used to prevent reinfestation, but there are certain requirements that must be fulfilled before a package can be made insect resistant. These include the use of insect-light construction and packaging materials that resist boring insects. The relative insect resistance of various packages and packaging materials is discussed, as are behavior traits such as egressive boring that enables insects to escape from packages and the ability of insects to climb on various packaging materials. Some successful and unsuccessful attempts to make various types of packages insect resistant are discussed, as are factors that must be considered in the selection or development of insect-resistant packages for radiation disinfested foods. The latter factors include biological and physical environments, length of storage periods, stresses on packages during shipment, types of storage facilities, governmental regulations, health requirements, and others.

7444 **Insect disinfestation of packed dates by gamma-radiation.** Ahmed, M.S.H.; Hameed, A.A.; Kadhum, A.A.; Ali, S.R. (Agriculture and Biology Dept., Nuclear Research Centre, Tuwaitha, Baghdad). pp 374-382 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The effect of gamma-radiation on insect disinfestation of commercially packed dry dates was studied in collaboration with the Iraqui Date Administration. The wrapping of "window carton lunch boxes" (each holding 250 g of dry dates, Zahdi variety) with polyethylene film, compared to cellophane, prevented reinfestation for a long period of storage if treated with 0.70 kGy of gamma-radiation. All live insects that were found in the irradiated boxes and tested were genetically sterile, and those in different developmental stages died within a short period of time without passing through metamorphosis. In all cases (treated or control batches), cellophane-sealed boxes proved to be more vulnerable to reinfestation. Dates packed in plastic cups, used for N/sub 2/ vacuum packaging, were also effectively disinfested by the same dose of radiation. The value of airtight packaging will certainly add to the advantage of the high penetration power of gamma-radiation relative to methyl bromide fumigation. Results of the assessment of the damaging ability of irradiated insects indicate that treatment of packed dates with 0.70 kGy is sufficient as far as quarantine measures are concerned where the possible increase in infestation rate, brought about by radio-resistant insect stages that usually constitute a small fraction in nature, is negligible.

7445 **Marketing and labelling of radiation insect-disinfested food and agricultural products.** Urbain, R.W.; Urbain, W.M. (Castle & Cooke, Inc., 50 California Street, San Francisco, CA 94111). pp 354-361 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Marketing procedures need to be designed specifically for the particular products involved. While most marketing efforts are directed toward the consumer, it is likely that with radiation insect-disinfestated foods, the principal effort will be concerned with food distributors and retailers. Labelling as "irradiated" should be at the option of the vendor and not mandatory. A three-step procedure for marketing is proposed: (1) identification of specific market need or opportunity; (2) test production and marketing; and (3) commercial production and marketing. It is suggested that information on irradiated foods directed toward answering potential consumer interests and concerns be made available.

7446 **Effect of irradiation on the extension of shelf life of tropical food products.** Avadhani, P.N.; Lian, O.B.; Nio, L.E. (Botany Dept., National Univ. of Singapore, Lower Kent Ridge Road, Singapore 0511). pp 166-174 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The effect of gamma-radiation with cobalt-60 at doses ranging from 02.5 to 2.00 kGy on selected local fruits and vegetables was studied. It was found that ripening was delayed in unripe chikus at 0.5 and 1.0 kGy. At similar doses fungal infection in ripe papayas was retarded. Ripening was accelerated and shelf life was prolonged in mature, unripe papayas. Other effects noted were: mangosteens were better preserved (0.25-0.40 kGy), pineapples showed core damage (0.5-2.0 kGy), limes were damaged (0.5-1.0 kGy), and brinjals kept fresh for several days (0.5-1.0 kGy). At similar doses, acceleration of ripening was noted for green chillies, and the shelf life was prolonged for red chillies.

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7447 **Suitability of low-dose gamma irradiation for disinfestation of several fruits.** Rigney, C.J.; Wills, P.A. (Gosford Horticultural Postharvest Lab., P.O. Box 355, Gosford, N.S.W.). pp 129-134 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

A number of fruits were treated with low radiation doses from 75 to 225 Gy to determine the suitability of this treatment for disinfestation against the Queensland fruit fly. No obvious effects on fruits were observed with Valencia oranges, table grapes, apples, pear, and tomatoes. Avocados were damaged by this treatment; an increase in vascular browning of fruit followed treatment with 75 to 225 Gy.

7448 **Quality of fresh fruits irradiated at disinfestation doses.** Moy, J.H.; Nagai, N.Y. (Dept. of Food Science and Human Nutrition, Univ. of Hawaii, Honolulu, HI 96822). pp 135-147 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Quality retention of fresh fruits treated with gamma-radiation for disinfestation is one of the criteria for the feasibility of the radiation process. The effectiveness of radiation disinfestation of Hawaii-grown papayas infested by three species of tropical fruit flies and California-grown citrus and stone fruits infested by Mediterranean fruit files (Ceratitis capitata) and the sensory qualities of these irradiated fruits were recently studied in Hawaii. Experimental results showed that papaya can be irradiated to 1.0 kGy without any adverse effects on its sensory and nutrient qualities. A radiation dose of 0.3 kGy should present no problems to the sensory qualities of California stone and citrus fruits. California citrus can tolerate higher doses (0.50-0.75 KGy) than stone fruits, especially if refrigerated storage follows irradiation. Better control of harvesting, shipping, and handling should also help retain the qualities of these irradiated fruits.

7449 **Preservation of fresh avocados by irradiation.** Karmelic, J. (Instituto de Investigaciones Tecnologicas, INTEC/CHILE, Casilla 667). pp 148-159 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Avocado is the fifth most important fruit in Chile, which exports fruits to Europe. The production of avocado has increased from 14,000 metric tons in 1978 to a projected 70,000 metric tons in 1985. The main problem of shipping fresh Chilean avocado to Europe has been its short shelf life, being around 24 days with a maximum of 30 days. To market fresh Chilean avocados in Europe, adequate keeping quality must be assured for 40 or more days. A project on the preservation of fresh Chilean avoqados supported by the International Atomic Energy Agency (IAEA) takes the approach of combining mild heat and low-dose gamma-radiation. Two varieties of avocados were studied (Hass and Fuerte) and two batches of each were treated: one at the beginning and the other at the end of the picking season. In each case a combination of heat treatment (46°C for 10 minutes) and irradiation was applied. Fruits were individually wrapped with flexible PVC and placed in cardboard boxes containing 20 each. Fruits treated with 25,50, and 100 Gy were compared with two controls: one with and another without individual wrapping.

7450 **Potential for gamma-radiation as a quarantine treatment for Caribbean fruit fly in citrus.** Spalding, D.H.; Davis, D.F. (Subtropical Horticulture Research Station, USDA/ARS, 13601 Old Cutler Road, Miami, FL 33158). pp 160-165 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The potential for using gamma-radiation as a quarantine treatment for the control of the Caribbean fruit fly (Anastrepha suspensa [Loew]) in citrus is being investigated by the Agricultural Research Service of the U.S. Department of Agriculture and the Florida Department of Citrus in cooperation with the U.S. Department of Energy and private industry. In dosage-mortality tests, pupae were recovered from infested grapefruits held at 25°C for six weeks following irradiation at 0.15 and 0.30 kGy. No insects were recovered from grapefruit irradiated at 0.60 and 0.90 kGy. Two adults emerged from the recovered pupae, one male at 0.15 kGy and one female at 0.30 kGy; both adults died without reproducing. Based on the number of pupae recovered, fly mortality was 98.9 percent at 0.15 kGy percent at 0.30 kGy, and 100 percent at 60 and 90 kGy. In phytotoxicity tests, noninfested grapefruits were held for four weeks at 10 or 16°C, followed by two weeks at 21°C, and then examined for radiation injury. Injury was minimal at 0.30 kGy, and the grapefruit had acceptable taste, no adverse chemical changes, and met Grade A standards when examined by Florida inspectors. Injury to the rind and off-flavors in juice and sections were often severe at higher dosages (0.60 and 0.90 kGy). Grapefruit irradiated at 0.60 and 0.90 kGy) showed rind breakdown and scald after storage. Scald was the dominant injury in October and December tests, and rind breakdown was the dominant injury in February, April, and May tests. Generally, injured areas developed decay during holding at 21°C..

7451 **Disinfestation and vase-life extension of orchids by irradiation.** Piriyathamrong, S.; Chouvalitvongporn, P.; Sudathit, B. (Dept. of Agriculture, Ministry of Agriculture and Cooperatives, Bangkok 10900). pp 222-225 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Studies on disinfestation and vase-life extension of orchids by irradiation were conducted to determine whether gamma-radiation can be effectively used to eliminate thrips and prolong the vase life of cut flowers. Cut flowers of Dendrobium Pompadour were subjected to Co-60 irradiation at 0, 50, 100, 150, and 200 krd doses 5 to 6 hours after picking. The flowers were separated into two groups. The first group was used to count the number of thrips. The other group was held at controlled room temperature (20°C and 80 percent RH) for 36 hours before being unpacked and placed in water. The results of two experiments illustrated that at 2 days after irradiation at 150 and 200 krad no thrips were found on the flowers, whereas on flowers untreated and those treated at 50 and 100 krad, a higher number of thrips were detected. As far as the vase life is concerned, treated flowers have a shorter life. Irradiation at 0, 50, 100, 105, and 200 krad doses resulted in average vase life of 18.75, 12.15, 10.85, 8.85, and 6.20 days, respectively, in the first test and 14.60, 10.05, 8.75, 7.35, and 6.85, respectively, in the second test. Increased doses of radiation caused flowers to wilt and drop off within a few days. Further study is being conducted.

7452 **Radiation disinfestation of tobacco leaves and coffee beans.** Soemartaputra, M.H.; Rosalina, S.H.; Rahayu, A.; Harsojo; Kardha, S. (National Atomic Energy Agency, Center for the Application of Isotopes and Radiation, Jakarta). pp 226-239 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The most important insects found on coffee and tobacco in storage are A. fasciculatus and L. serricorne, respectively. Some genera of mold, such as Rhyzopus, Aspergillus, Penicillium and Mucor, were found on stored coffee. A preliminary study of radiation disinfestation of coffee beans was carried out using 24 bags (each 1.5 kg) of Arabica coffee. Each bag was infested with 100 adults of 1-day-old to 8-day old A. fasciculatus. One month after infestation, the bags were divided into 6 groups (4 bags each). Five groups were irradiated with doses of 0, 0.05, 0.10, 0.20, and 0.40 kGy, while the sixth group was fumigated with about 3 g phosphine-m/sup 3/. The work is still in progress. The preliminary data (insect density, percentage weight loss of coffee beans, and mold in-

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festation) from 10 observation periods during 20 weeks of storage after treatment was reported. Radiation disinfestation of tobacco was done on 36 export-size bales (each 100 x 75 x 40 cm in size and about k00 kg in weight) of tobacco. Each bale was infested with larvae, pupae, and adults of L. serricorne. One week after infestation, the bales were divided into 3 groups, the first group kept untreated as controls, the second group irradiated at a dose range of 0.30 to 0.60 kGy, and the third group fumigated with about 3 g phosphine/m/sup 3/. Insect density, leaf moisture content and mold infestation will be observed after 0, 2, 4, and 6 months of storage. The work was begun in October 1983 and data presently are being collected.

7453 **Cesium-137 as a radiation source.** McMullen, W.H.; Sloan, D.P. (U.S. Dept. of Energy, Albuquerque Operations Office, P.O. Box 5400, Albuquerque, NM 87115). pp 245-265 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The U.S. Department of Energy (DOE) Byproducts Utilization Program (BUP) seeks to develop and encourage widespread commercial use of defense byproducts that are produced by DOE. Cesium-137 is one such byproduct that is radioactive and decays with emission of gamma rays. The beneficial use of this radiation to disinfect sewage sludge or disinfest food commodities is actively being pursued by the program. The radiation produced by cesium-137(Cs-137) is identical in form to that produced by cobalt-60(Co-60), an isotope that is widely used in commercial applications such as medical product sterilization. The choice of isotope to use depends on several factors ranging from inherent properties of the isotopes to availability and cost. The BUP, although centrally concerned with the beneficial use of Cs-137, by investigating and assessing the feasibility of various uses hopes to define appropriate circumstances where cesium or cobalt might best be used to accomplish specific objectives. This paper discusses some of the factors that should be considered when evaluating potential uses for isotopic sources.

7454 **Food irradiation experience in a large medical-products irradiator.** O'Sullivan, E.T.; Gunby, A.L. (International Nutronics, Inc., 1237 N. San Antonio Road, Palo Alto, CA 94303). pp 276-282 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

Recent international and U.S. interest in irradiation as an alternative to chemical disinfestation has set the stage for pilot-plant food irradiation programs. Lessons learned in designing and operating large medical-product irradiators have significant value in designing plants for food irradiation. International Nutronics is utilizing its medic-products irradiation facility in Irvine, California, to gather data for extrapolation to full-scale agricultural product irradiator designs. Data generated to date show that excellent dose distribution and source utilization can achieved for product containers of a practical size. Extrapolation of these date to a field-located plant of 400 tons-day capacity has resulted in a cost-effective preliminary design capable of handling disinfestation at less than one cent per pound of product.

7455 **Food processing with electrically generated photon irradiation.** Matthews, S.M. (Univ. of California, Lawrence Livermore National Lab., P.O. Box 808 Livermore, CA 94550). pp 283-294 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

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Economic constraints require that a food irradiation processing facility have a throughput of approximately 1 MGy ton/day (0.91 MGy m.t./day) requiring 3 MegaCuries (MCi) of cobalt-60 at each site. This requirement means that the total world amount of cobalt-60 would have to be increased by about 60 percent just to handle the California almond and raisin crop during peak season. It is doubtful that public opinion would allow the increased distribution of radioactive isotopes, with the resultant burden upon the transportation networks, as a price to be paid to eat irradiated food. Electric sources have characteristics that allow the production of more penetrating, uniform, and efficient radiation that is available from nuclear isotopes. The heart of the electric radiation source is the electron accelerator. At present, there are no accelerators commercially available that can meet the requirements for food irradiation processing. However, the U.S. Department of Defense-funded beam weapons programs have provided a very promising accelerator technology at the Lawrence Livermore National Laboratory. If this technology were to be commercialized, it appears that the required accelerators would be available for US$1.5 million apiece, and quite possibly for less than this amount. A conceptual design for a portable electric food irradiation processing machine is presented and analyzed for cost, assuming the required accelerators are available for $1.5 million each. It is shown that food can be processed for 1 kGy for a price of $5.98/ton ($6.59/m.t.).

7456 **A commercial multipurpose radiation processing facility for Hawaii.** Welt, M.A. (Radiation Technology, Inc., 108 Lake Denmark Road, Rockaway, NJ 07866). pp 295-313 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The State of Hawaii offers a unique challenge for the designer of an economically feasible radiation processing system. Based on the prevailing agricultural export requirements, the radiation facility must be capable for handling a variety of bulky fruit and vegetable products for insect disinfestation purposes and, yet, provide proper economies for the users of the facility. A capability must exist for irradiating other types of products requiring higher doses, e.g., fish and shellfish products for shelf-life extension, which might require a dose approximately eight times higher than the disinfestation dose, or even medical product or a food sterilization dose, which would be approximately twelve times higher than the required shelf-life extension dose. The Radiation Technology Model RT 4101-4048 radiation processing facility provides the necessary versatility and operational reliability to meet the challenge. The technical features and economic analyses demonstrate the advantages of this computer-operated pallet irradiation system. Actual performance data from the Radiation Technology subsidiary operations in West Memphis, Arkasas, and Burlilngton, North Carolina, are presented along with photographs of the proposed system for Hawaii.

7457 **Radiation sterilization facility for melon fly.** Danno, A. (Faculty of Agriculture, Kagoshima Univ., 1-21-24 Korimoto, Kagoshima 890). pp 314-326 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The melon fly (Dacus cucurbitae Coquillett) has been observed in Amami Island since 1975. Kagoshima Prefecture has had a melon fly eradication project underway since 1979. A mass-fearing facility and a radiation sterilization facility were constructed in Naze in March of 1981. In the early stages of the project, sterile insects were produced at the rate of 4 x 10/sup 6/ pupae/week. In the later stages, the activity of the project was enlarged by tenfold. The conditions for design of the radiation sterilization facility, which has been developed with a central control system for automated irradiation, are examined from an engineering standpoint.

7458 **Economic feasibility of radiation insect disinfestation of foods.** Urbain, W.M. (Michigan State Univ., 10645 Welk Drive, Sun City, AZ 85373). pp 333-341 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

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Little actual experience is available today to provide proved data on costs for the irradiation of foods. The various cost factors

for food irradiation have been identified, however, and ordinary costing procedures are applicable. As is customary, costs can be divided into capital or fixed costs and operating or variable costs. Particularly with regard to capital costs, appropriate inputs in the domain of irradiation technology are needed. Some of these represent a balancing of technical factors and options in order to minimize costs. One commercial food irradiation application has provided actual cost data on the operation of an irradiator. To determine economic feasibility of a particular planned usage of radiation disinfestation, it is suggested that a cost analysis is outlined in this paper and in accord with ordinary business practices be made.

7459 **Some aspects of consumer acceptance of irradiated foods.** Josephson, E.S. (Dept. of Nutrition and Food Science, Massachusetts Institute of Technology, Cambridge, MA 02139). pp 342-349 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

In common with the introduction of any new food or food process into the marketplace, consumer acceptance is an aspect that must be addressed if commercial application of food irradiation is to be successful. In some countries, like the United States, there is no provision in the law or precedent to permit testing of irradiated foods for consumer acceptance - except, for example, by the military and through the use of special hospital patients whose immunity to infections have been suppressed, prisoner volunteers, conscientious objectors, and astronauts - before unlimited clearances are granted by appropriate health authorities. This paper describes some of the pitfalls in running consumer tests. A carefully prepared experimental design is crucial, encompassing variables such as the attitude of the vendor, packaging, labelling, the relative cost to the consumer of the irradiated (test) foods compared with the nonirradiated (control) foods, the methods for handling, storing, and preparing the foods, choice and number of testers, and the general environment in which the test is run.

7460 **Acceptance and marketability of the food irradiation technology.** Sivinski, J.S. (CH2M HILL, 6121 Indian School Road, N.E., Suite 206, Albuquerque, NM 87110). pp 350-353 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The food irradiation technology has been struggling for forty years for acceptance and utilization. The issue of consumer acceptance is addressed and judged not to be the critical factor in terms of priority and timing. The producing/processing marketing industries must first accept the technology for valid business or social reasons. If they become convinced that they cannot afford to pass up the technology, they will accept the process and offer irradiated products. These industries understand public acceptance and use professionals in market development and advertising to achieve consumption of their products. Consumer acceptance can best be developed by the food industry, while the research and development community, in concert with national and international agencies, can and should provide the industry with every assistance in reaching a consensus on the validity of food irradiation as an appropriate and useful technology.

7461 **Low-dose irradiation: A promising option for trichina-safe pork certification.** Sivinski, J.S.; Switzer, R.K. (CH2M HILL, 6121 Indian School Road, N.E., Suite 206, Albuquerque, NM 87110). pp 181-188 of Radiation disinfestation of food and agricultural products. Moy, J.H. Honolulu, HI; University of Hawaii at Manoa (1985). (CONF-8311102—).

From International conference on radiation disinfestation of food and agricultural products; Honolulu, HI, USA (14 Nov 1983).

The parasitic nematode Trichinella spiralis, the causative agent of pork trichinosis has long been a blemish on the U.S. public health record. Trichinosis remains a problem in the United States today, both as a threat to human health and as an expensive stigma on the U.S. Pork industry. Progress in swine management since 1950 has improved the situation, but the United States still has one of the highest rates of trichinosis among the industrialized nations. A promising method for rendering pork noninfectious for trichina is gamma irradiation. Extensive research on the irradiation of trichina-infested meat has indicated that the parasitic disease cycle could be effectively broken by relatively low levels of radiation. Most researchers agree that a dose of 0.3 kGy (30 krad) delivered to pork should render fresh pork trichina-safe. A program has been initiated to assess the potential benefit from a cesium-137-based pork irradiation program. This program includes the following elements: (1) research to verify the radiation control of trichinae under conditions that simulate the modern pork industry; (2) a logistic and economic feasibility study of a large-scale irradiation program, and (3) development of pork irradiation demonstration facility.

# 56 BIOMEDICAL SCIENCES, APPLIED STUDIES

## 5601 Radiation Effects

*REFER ALSO TO CITATION(S) 7424*

7462 **(DOE/ER/60147—T2) The development of in vitro mutagenicity testing systems using T-lymphocytes: Final report, August 14, 1983-October 31, 1986.** Albertini, R.J. (Vermont Univ., Burlington (USA)). Oct 1986. Contract AC02-83ER60147. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002534.

The development of in vitro mutagenicity assays employing human T-lymphocytes is described. Conditions were established which allow the in vitro growth and cloning of human T-lymphocytes, as well as methods for selection and quantification of 6-thioguanine resistant (TG/sup r/) mutants. In particular, a procedure was established to measure the in vitro induction of TG/sup r/ mutants by gamma irradiation having defined the phenotypic expression time and optimal selection conditions. 18 refs.

7463 (DOE/EV/00119—261, pp 1-4) **Toxicity of $^{239}$Pu and $^{226}$Ra in young adult beagles: risk estimate in man.** Miller, S.C. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

The overall objective of this research program is to predict the risk to humans following exposure to $^{239}$Pu. The beagle was originally selected for this program because it is relatively long-lived and has skeletal functions and structure analogous to young adults humans, simulating that of a young adult radium dial painter or occupationally exposed person. Young adult (17 month-old) beagles from the moderately inbred colony at the University of Utah were administered one intravenous injection of $^{239}$Pu (0.0007-2.88 μCi/kg in 238 dogs) or $^{226}$Ra (0.007-10.4 μCi/kg in 119 dogs), and compared to appropriate age-matched control beagles. All beagles have been and are being observed clinically throughout their expected 12 to 15 year post-injection lifespan. A thorough clinical and post-mortem survey is conducted to determine causes of death or lesions at death. The clinical findings are being encoded using SNOMED terminology and entered into a computerized database. All beagles in the $^{226}$Ra study are dead and the data are being analyzed and published. The shape of the curve for dose vs. bone tumor incidence is highly linear up to average skeletal doses of 2200 rads. In higher dose groups, the time to tumor appearance is decreased and skeletal tumors occur in almost all animals. The $^{226}$Ra response is being compared with the $^{239}$Pu response in beagles. This toxicity ratio will allow use of the bone tumor response in the radium dial painters to predict the toxicity of plutonium for bone tumor induction in man.

7464 (DOE/EV/00119—261, pp 5-10) **Toxicity of $^{239}$Pu and $^{226}$Ra in juvenile and mature beagles: risk estimation in man.** Bruenger, F.W. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

The objective of this research is to study the effect of age at time of exposure to $^{239}Pu$ or $^{226}Ra$ on the formation of osteosarcomas and other radiation-induced lesions. The study was initiated when it became known that the development of radiation-induced lesions was dependent on biological parameters that varied with age. The project is composed of a serial sacrifice program in which the biological and dosimetric parameters are being explored, and a toxicity study in which the induction and development of radiation-induced lesions are being observed. Of the original 182 beagles in this study, 81 were alive as of January 1, 1986. Of the 101 dead dogs, 42 were tentatively diagnosed as having at least one osteosarcoma. Between January 1, 1985 and December 31, 1985 a total of 21 beagles from the chronic toxicity project died. This includes 6 mature and 5 juvenile beagles injected with Pu, 5 mature and 3 juvenile beagles injected with Ra and one control dog. Of these dogs, 10 died with at least one primary osteosarcoma. A detailed statistical report is given.

7465 (DOE/EV/00119—261, pp 11-14) **Mechanisms of internal emitter skeletal toxicity.** Jee, W.S.S. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

The purpose of this program is to determine the mechanisms for the induction of skeletal cancers in dogs and man by $\alpha$-emitting bone-seeking radionuclides from the nuclear fuel cycle. The role of microdistribution of radium-226 and plutonium-239, bone metabolism, bone cell turnover, and localized bone cell dosimetry in bone can induction will be determined. The osteogenic cell dose will be measured in dogs to develop better quantitative dose response information. Skeletal carcinogenesis models will be developed by correlating the local dosimetry, tumor site and incidence, age-dependent skeletal biology (bone morphometry, bone cell at risk, bone cell turnover, residence time and fate, remodeling rate, growth pattern and rate, hormonal influences, manipulation of bone cell populations of the bone modeling and remodeling systems, etc.). The authors will test the hypothesis that the frequency of osteosarcomas is proportional to the average dose delivered to cells at risk. They will also attempt to explain experimentally found toxicity ratios between volume- and bone surface-seeking radionuclides on the basis of radiation dose ratios.

7466 (DOE/EV/00119—261, pp 15-20) **Radionuclides in rodents.** Taylor, G.N. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

Studies are being conducted in mice comparing the toxicity of radium-226, plutonium-239, americium-241, californium-249 and californium-252 in C57B1/Do (albino) mice and the toxicity of americium-241, plutonium-239 and radium-226 in deer mice (Peromyscus maniculatus) and grasshopper mice (Onychomys leucogaster). These experiments will ultimately enable comparison of the toxicity of the above actinide toxicity in man to be made using radium toxicity as the baseline.

7467 (DOE/EV/00119—261, pp 21-26) **$^{224}Ra$ toxicity in humans and laboratory animals.** Mays, C.W. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

German and US investigators are evaluating the $\alpha$-particle-induction of bone sarcomas and other diseases in about 2300 German patients who were injected with $^{224}Ra$ after World War II. With the toxicity ratios being established in laboratory animals at the University of Utah, risks to humans from $^{239}Pu$ and other emitters can be predicted.

7468 (DOE/EV/00119—261, pp 27-28) **Deposition, retention and toxicity of selected actinide elements in beagles.** Stevens, W. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

As March 18, 1986, 104 (90%) of the 116 dogs originally injected with $^{241}Am$ had died. Forty-two animals developed osteosarcomas, one a fibrosarcoma, two a chondrosarcoma, and one an undiagnosed bone neoplasm. A number of liver-derived tumors were found at autopsy, ten dogs died with liver and/or kidney degeneration, four died with liver tumors as the primary cause of death and the remainder died with a variety of age-related pathological lesions. Thyroid degenerations also a prominent $^{241}Am$ induced lesion. Of the 36 animals in the $^{249}Cf$ study, 29 (81%) have died; 11 with osteosarcoma. Thirty of the 36 dogs in the $^{252}Cf$ study died, ten with skeletal cancer. The dogs at the important low-dose levels are succumbing to the late effects of radiation and/or age-related causes. One of the dogs injected with einsteinium died of kidney failure, presumably unrelated to irradiation. The behavior of these elements in the beagle has been defined and the principal target organs (liver and skeleton) identified. The equations that describe the retention of $^{241}Am$, $^{249}Cf$, $^{252}Cf$, /sup 243/244/Cm, and $^{253}Es$ in these organs have been determined. The preliminary estimates of the relative biological effectiveness compared to $^{239}Pu$ made for the actinides (principally $^{241}Am$, $^{249}Cf$ and $^{252}Cf$) cannot be considered reliable until the animals given the smallest quantities of the nuclide have died.

7469 (DOE/EV/00119—261, pp 31-32) **Dosimetry of internal emitters relative to carcinogenesis.** Lloyd, R.D. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

This project has the goals of providing dosimetry data on which to base risk estimates for humans for biologically significant radionuclides to which they can be exposed, and estimating the comparative risks of environmental and occupational exposures to these nuclides. Biological effects in humans from internally deposited radioactivity have been observed from $^{226}Ra$ (in skeleton), $^{224}Ra$ (in skeleton and soft tissues) and $^{232}Th$ as thorotrast (in soft tissues and skeleton). For example, assuming that the toxicity ratio ($^{239}Pu$ effect per rad/$^{224}Ra$ effect per rad) is roughly similar among mammals, the effectiveness of $^{239}Pu$ in humans can be estimated from the effectiveness of $^{224}Ra$ in humans and the toxicity ratio in animals. The use of a variety of animal models and of more than one data base for humans adds confidence to the procedure.

7470 (DOE/EV/00119—261, pp 37-40) **Interlaboratory bone microdosimetry and morphometry studies: mechanism of radiation-induced bone cancer.** Jee, W.S.S. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

These studies are part of the interlaboratory cooperative program on skeletal microdosimetry among Battelle-Pacific Northwest Laboratories (PNL), Inhalation and Toxicology Research Institute (ITRI), Laboratory for Energy-Related Health Research, University of California, Davis (LEHR), and the University of Utah (U of U) under the guidance of the bone dosimetry section of OHER's dosimetry Task Group. The U of U Radiobiology Division will supply skeletal microdosimetric data on bones and static and dynamic skeletal histomorphometric data from beagles that received plutonium, transplutonic elements and radium. Special emphasis will be on studies of aerosols of varying solubilities because solubility is the prime determinant of the rate at which the nuclide reaches the skeleton and causes osteosarcoma. This dosimetric and morphometric data should improve the calculation of local dose, contribute to a better understanding of the mechanism of radiation-induced bone tumors and provide means to predict risk to humans from possible exposure to radionuclide-containing aerosols. The program for the processing of information and computerized analyses of $^{226}Ra$ and $^{241}Am$ autoradiographs are operation. Currently, the major effort is to generate the required autoradiographs.

7471 (DOE/EV/00119—261, pp 41-44) **Thermoluminescence studies of NTS-related fallout exposures.** Haskell, E.H.; Wrenn, M.E.; Kaipa, P.L. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

The possible health effects from fallout radiation resulting from atmospheric testing at the Nevada Test Site (NTS) during the 1950's and 60's was refocused in 1979 by the report of apparent increases in childhood leukemias in regions downwind of the NTS. A program is discussed which established a dosimetry technique for the measurement of low doses of radiation in common building bricks. A considerable amount of technique development has been in progress throughout the course of the pilot study. Since its development, considerable progress has been made on increasing the accuracy and reliability of the technique.

7472 (DOE/EV/00119—261, pp 45-48) **Thermoluminescence studies in Hiroshima and Nagasaki.** Haskell, E.H.; Kaipa, P.L.; Wrenn, M.E. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

This project has the goal of providing independent measurements of gamma-ray doses to bricks and tiles which were present in Hiroshima and Nagasaki at the time of the a-bomb detonations. The measurements will be used to validate computational models to be used for assigning dose estimates to survivors in those cities.

7473 (DOE/EV/00119—261, pp 49-52) **Summary of dosimetry, pathology, and dose response for bone sarcomas in beagles injected with $^{226}$Ra.** Wrenn, M.E.; Taylor, G.N.; Stevens, W.; Mays, C.W.; Jee, W.S.S.; Lloyd, R.D.; Atherton, D.R.; Bruenger, F.W.; Kimmel, D.B.; Miller, S.C. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

One hundred and sixty dogs given single intravenous injections of $^{226}$Ra citrate at age 17 +/- 2 months (116) or a non-radioactive solution (44 controls) were part of a 30 year long experiment to determine the relative radiotoxicity of injected $^{226}$Ra and $^{239}$Pu. The authors report a preliminary summary of the results of the $^{226}$Ra study. Skeletal development of the beagles used in this study is analogous to a young adult human, simulating that of a young adult radium dial painter or occupationally exposed person. Injected dosage of $^{226}$Ra, average skeletal dose, and number of dogs and dogs developing bone sarcomas in each group are presented. The lowest nominal injected activity was 0.007 μCi/kg. Each of the 8 dosage levels contained about 12 dogs, except for 23 dogs at 0.06 μCi/kg and 25 dogs at 0.02 μCi/kg.

7474 (DOE/EV/00119—261, pp 53-60) **Dosimetric and biological study of injected $^{226}$Ra in mature beagle dogs.** Bruenger, F.W.; Pearson, J.E.; Lloyd, R.D.; Williams, F.H.; Polig, E. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

Seven mature beagles of age 60 months or older were injected with 1,1 μCi $^{226}$Ra/kg and sacrificed serially between 7 days and 1 year thereafter to study the early dosimetry of $^{226}$Ra and the associated biological parameters. The bone markers tetracycline and calcein were administered to all dogs sacrificed at 60 days or longer after $^{226}$Ra injection. This will allow a later evaluation of local bone turnover rates. The experiment provided detailed information on the early retention and distribution of $^{226}$Ra and basic data on the fractional skeletal mass of the whole body and the fractional mass of individual bones, the associated ash weights and ash weight/wet weight ratios. 3 tables.

7475 (DOE/EV/00119—261, pp 61-66) **Hematopoietic tumors in beagles with body burdens of bone-seeking radionuclides.** Taylor, G.N.; Shabestari, L.; Mays, C.W.; Wrenn, M.E.; Keller, S.; Angus, W. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

The cumulative tumor rate for hematopoietic neoplasms in beagles with long-term body burdens of $^{90}$Sr, $^{224}$Ra, $^{226}$Ra, $^{228}$Ra, $^{228}$Th, $^{239}$Pu, $^{241}$Am, /sup 243/244/Cm, $^{249}$Cf, $^{252}$Cf or $^{253}$E was similar to that of the non-radioactive control dogs. In both instances, the earliest tumor appeared at 5 to 6 years of age and the incidence rate began to increase appreciably at approximately 10 years of age. Hematopoietic neoplasia was principally a disease of the older animals, and a definite relationship to the radionuclide burden was not apparent when all of the neoplasms were combined under the general category of hemic tumors. However, a difference between the control and irradiated groups was noted in the spectrum of tumor types. All of the myeloid and mast cell tumors occurred in the irradiated dogs.

7476 (DOE/EV/00119—261, pp 67-70) **Osteogenic potential of bone-lining cells in the adult skeleton.** Bowman, B.M.; Miller, S.C. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

Radiation-induced osteogenic sarcomas are believed to arise from proliferating osteogenic precursor cells. The identity and location of these cells in the adult skeleton is not well understood. In order to determine reliable cell dose estimates, it is important to determine the osteogenic pathway in the adult skeleton. Bone-lining cells (BLCs) cover inactive endosteal surfaces in the adult skeleton of long-lived animals. BLCs are flat elongated cells which are directly apposed to the bone surface. They have cell processes extending into canaliculi and have gap junctions at some contacts with other bone-lining cells. The morphology of the bone-lining cell and its proximity to the bone surface can only be resolved at the ultrastructural level. These cells are a distinct morphologic phenotype but have been referred to by a variety of names including resting osteoblasts, surface osteocytes, and flattened mesenchymal cells. The BLC, as a distinct phenotype, should not be confused with the more descriptive term cells lining the bone surface of bone lining cells, sometimes used to include any cell near the bone. The purpose of the study was to determine what role, if any, the bone-lining cells have in the osteogenic process. Do these cells proliferate and contribute to the population of osteoblasts?

7477 (DOE/EV/00119—261, pp 77-86) **New directions in risk evaluation.** Mays, C.W.; Lloyd, R.D.; Taylor, G.N.; Slater, D.L. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

In the beginning it was improperly believed that radiation could induce cancer only after a threshold dose was exceeded and that the risk per rad was similar in humans an laboratory animals. Average skeletal dose is useful, but the doses to the target cells are also needed. Toxicity ratios established in animals are a powerful tool in transforming the known risk to humans from one type of irradiation into a predicted risk to the same organs from another type of irradiation. Especially where radiation causes multiple types of disease, it is important to use life-table methods to correct for competing causes of death. The authors are searching for an index of total detriment that includes both cancer incidence and life shortening.

7478 (DOE/EV/00119—261, pp 91-94) **Kidney damage caused by Po-210.** Bruenger, F.W.; Mays, C.W.; Taylor, G.N. 31 Dec 1985. NTIS, PC A09/MF A01. File Number DE86015873. (COO—119-261).

In Research in radiobiology. Annual report, Internal Irradiation Program.

Severe nephrosis developed in a number of dogs that were 60 months or older when injected with Ra-226. This $^{226}$Ra was in partial equilibrium with its long-term descendants $^{210}$Pb and $^{210}$Po. The cause of the renal toxicity was evaluated. It was known from previous experiments that injection of 10 μCi $^{210}$Pb/kg, recently separated from $^{210}$Po, did not cause the kidney syndrome in young adult dogs and no post-injection kidney damage was seen in young adult dogs injected with 8-10 μCi $^{226}$Ra/kg that contained an average of 6% of the equilibrium of $^{210}$Pb and $^{210}$Po. In order to determine the reason for the toxicity observed in the old dogs, the following experiment was conducted. Two beagles were injected at 83 months of age with 10 μCi $^{226}$Ra/kg that had been recently separated from in grown $^{210}$Pb and $^{210}$Po. Two additional beagles were

injected at 83 months of age with 3.6 μCi $^{210}$Po/kg. The ratio of 3.5 μCi $^{210}$Po/kg to 10 μCi $^{226}$Ra/kg corresponded to the maximum in growth of $^{210}$Pb in the injection solution of the old dogs which developed nephrosis. The hypothesis to be tested was that 10 μCi $^{226}$Ra/kg recently separated from $^{210}$Pb and $^{210}$Po would not lead to kidney damage but that 3.6 μCi $^{210}$Po/kg could cause the syndrome.

7479 (INIS-mf—10308, pp 111-115) **Radioactivity monitoring of the population.** Schmier, H.; Dehos, R. (Bundesgesundheitsamt, Neuherberg, Germany, F.R. Inst. fuer Strahlenhygiene). 1985. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87750072.

In 30 years of monitoring environmental radioactivity in the Federal Republic of Germany.

The Institute for Radiation Hygiene of the Federal Health Office is acting as the directing centre for radioactivity monitoring of the population, collecting all data measured in the FRG for assessment of the radiation exposure due to incorporation of long-life radioactive substances. The evaluation of measured Sr-90 data in the human skeleton is given in a table classified by age. The assessment of Cs-137 exposure is based on whole-body measurements carried out by three institutes (in Berlin, North-Rhine-Westphalia, and Karlsruhe). The averaged results show that the Cs-137 exposure of the population has been remaining constant over the last five years.

7480 (PB—86-246279/XAB) **Laboratory-determined concentration factors and elimination rates of some anthropogenic radionuclides in marine vertebrates and invertebrates. Final report.** Harrison, F.L. (Lawrence Livermore National Lab., CA (USA)). Jul 1985. 122p. NTIS, PC A06/MF A01.

Literature is reviewed and summarized with regard to concentration factor values and biological elimination rates determined in laboratory experiments for several anthropogenic radionuclides. Comparison is made with concentration factors measured in situ in the marine environment.

7481 (PNL-SA—14090) **Implications of human tissue studies.** Kathren, R.L. (Pacific Northwest Lab., Richland, WA (USA)). Oct 1986. Contract AC06-76RL01830. 19p. (CONF-861044—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002063.

From Hanford Life Sciences symposium: radiation protection-a look to the future - celebrating four decades of research at Hanford; Richland, WA, USA (21 Oct 1986).

Through radiochemical analysis of voluntary tissue donations, the United States Transuranium and Uranium Registries are gaining improved understanding of the distribution and biokinetics of actinide elements in occupationally exposed persons. Evaluation of the first two whole body contributions to the Transuranium Registry revealed an inverse proportionality between actinide concentration and bone ash fraction. The analysis of a whole body with a documented $^{241}$Am deposition indicated a significantly shorter half-time in liver and a greater fraction resident in the skeleton than predicted by existing models. Other studies of the Registries are designed to evaluate in vivo estimates of actinide deposition with those derived from postmortem tissue analysis, compare results of animal experiments with human data, and reviw histopathologic slides for tissue toxicity that might be attributable to exposure to uranium and the transuranic elements. The implications of these recent findings and other work of the Registries are discussed from the standpoint of their potential impact on biokinetic modeling, internal dose assessment, safety standards, and operational health physics practices.

7482 **Need for probabilities in cancer litigation.** Bond, V.P. (Brookhaven National Lab., Upton, NY). *Nuclear News (La Grange Park, Illinois);* 29: No. 10, 62-66(Aug 1986).

The third article in a series on radiation and the courts considers the new concept of probability of causation (PC), which the author concludes is the best of imperfect approaches. The problem arises from the medical inability to state that the particular cancer was the result of a specific exposure to radiation. Epidemiological and statistical evidence as the basis for probable cause has precedents in other situations where absolute certainty is unattainable. Alternatives to PC include threshold dose levels, referrals to judges with demonstrated scientific understanding, and improvements in the legal skills used in trying cases. Although PC yields more consistent results, the approach is best because it encompasses the advantages of the other approaches. 20 references.

## 5603 Chemicals Metabolism And Toxicology

*REFER ALSO TO CITATION(S) 7280, 7313, 7336, 7355*

7483 (ANL/SER—7) **Synfuels environmental research program for high-Btu coal gasification: health effects summary report.** Reilly, C.A. Jr.; Wilzbach, K.E.; Stetter, J.R.; Haugen, D.A.; Kirchner, F.R.; Stamoudis, V.C.; Peak, M.J.; Matsushita, T.; Boparai, A.S.; Jones, R.E. (Argonne National Lab., IL (USA)). Oct 1986. Contract W-31-109-ENG-38. 36p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87002194.

Process materials from two coal gasification pilot plants were evaluated for their toxicologic potential by investigators in the Synfuels Environmental Research Program at Argonne National Laboratory. The process samples were collected at the HYGAS fluidized-bed gasifier operated by the Institute of Gas Technology (Chicago, IL) and at a slagging fixed-bed gasifier at the University of North Dakota Energy Research Center (UNDERC; Grand Forks, ND). A tiered approach was used or the toxicologic evaluation. The cytotoxicity and genotoxicity of the materials were first assessed with a battery of short-term cellular screening assays. Selected toxic materials were then studied in a number of acute and chronic whole-animal toxicity assays, including tests of carcinogenicity. In the screening assays, a number of materials from both gasifiers were found to be genotoxic and cytotoxic. All HYGAS materials except quench waters yielded nonvolatile organic (NVO) fractions containing mutagenic components as determined in the Ames Salmonella assay. Fewer materials were tested in whole-animal assays. HYGAS recycle oil was slightly toxic in an acute oral toxicity assay ($LD_{50}$ was 1.3 g/kg). HYGAS recycle oil and char slurry oil caused dermal response in rabbits. NVO fractions of a HYGAS LTR gas condensate, pretreater quench water, char slurry oil, cyclone slurry, and recycle oil were eye irritants. HYGAS recycle oil and UNDERC tar were dermal carcinogens in mice.

7484 (DOE/ER/60015—2) **[Carcinogen-DNA adducts: Linkage site and conformation]: Progress report, 1985-86.** (New York Univ., NY (USA)). 1986. Contract AC02-81ER60015. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002523.

DNA adducts of known specific structure from small DNA fragments were prepared from known or suspected carcinogenic aromatic amines and amides. These adducts most frequently form between the guanine base and the nitrogen of the amine. Two types of adducts are known including those in which the nitrogen is acetylated (N-acyl derivatives) and those in which the acetyl group has been lost. The goal is to develop procedures which will enable the selective formation of specific adducts, particularly at the oligonucleotide level. It is essential that the adducts accurately known structure, and be in high purity. The reaction must be efficiently executable at the oligonucleotide level. It has been shown that the nature of the substitution, at the C-8 position of guanine for example, is such that conventional oligonucleotide synthesis, carried out with a modified base is not practicable. Both acidic and basic conditions, either of which is required for the deblocking conditions normally used in such approaches, leads to degradation of the modified base. The studies described here have taken a multifaceted approach with these points in mind. 1 fig., 1 tab.

7485 (PB—86-240934/XAB) **Retrospective view of the value of short-term genetic bioassays in predicting the chronic effects of diesel soot.** Lewtas, J.; Williams, K. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). Aug 1985. 26p. (EPA—600/D-86/189). NTIS, PC A03/MF A01.

In retrospect, it is now safe to conclude that short-term mutagenicity assays were not only useful but instrumental in: (1) indicating that diesel soot was potentially carcinogenic and should be

evaluated in chronic animal cancer bioassays, (2) identifying $NO_x$-PAHs as potential carcinogens in this very complex mixture, (3) providing initial evidence that the mutagens were bioavailable, and (4) estimating the relative importance of various sources and fuels and other factors that can influence human exposure to carcinogens. This is not to say that short-term bioassays used alone can accomplish all of this. However, used in combination with chemical/analytical methods and toxicological tools, short-term genetic bioassays have become a critical component of many environmental-health studies. Although substantial advances in our knowledge of the toxicology of diesel emissions have been made since 1978 when the initial observation that the organics extracted from diesel soot were mutagenic, a number of important questions remain not only for diesel emissions but for other combustion sources as well.

7486 **(PB—86-240967/XAB) Model of the relative contribution of atmospheric lead to total human lead exposure in the united states. Final report.** Elias, R.W. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 18p. (EPA—600/D-86/180). NTIS, PC A02/MF A01.

This paper describes a systematic evaluation of the total lead exposure of humans from both natural and anthropogenic sources. The evaluation is a multi-media approach that establishes an intermediate step in modelling the relationship between air lead and tissue lead. The model summarizes the total human exposure to lead from all sources in anticipation that such information can be correctly applied to physiological models that interpret the relationship between lead exposure and tissue lead concentrations. Only those pathways that expose the human body to lead in the human environment are discussed. The model does not attempt to define exposure in natural ecosystems nor is it concerned with details of the physiological processes affecting the distribution of lead within the human body.

7487 **(PB—86-241015/XAB) Relative contribution of lead from anthropogenic sources to the total human lead exposure in the United States. Final report.** Elias, R.W. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 12p. (EPA—600/D-86/184). NTIS, PC A02/MF A01.

The paper evaluates human exposure to lead at a baseline level for persons living in non-urban communities away from stationary or mobile sources of lead, eating typical diets, and engaging in no lead-related occupational or avocational activities. Relative contributions of atmospheric and metallic lead are evaluated for each exposure pathway. For this baseline situation, perhaps 40 to 55% of the total human exposure to lead is of atmospheric origin. Beyond the baseline level, additional exposure factors can be determined for other environments (e.g. urban, occupational, smelter communities) and for certain habits and activities (e.g., pica, smoking, drinking, and various hobbies), with variations for age, sex, or socioeconomic status. Although quantification of these factors is uncertain, they provide guidelines in determining relative exposures under differing environmental conditions. The added exposure factors can also be partitioned into atmospheric, metallic, and pigment lead.

7488 **Response of soybean to low concentrations of ozone. II. Effects on growth, biomass allocation, and flowering.** Amundson, R.G.; Raba, R.M.; Schoettle, A.W.; Reich, P.B. (Boyce Thompson Institute, Ithaca, NY). *Journal of Environmental Quality;* 15: No. 2, 161=167(Apr-Jun 1986). Contract AC02-77EV04368.

Soybean plants were subjected to ozone ($O_3$) and water stress to determine whether the two stresses interact to alter growth. Potted soybean (Glycine max [L.] Merrill cv. Hodgson) plants were exposed to $O_3$ for 6.8 h daily in four controlled environment chambers. The air supply to the chambers was filtered, and constant amounts of $O_3$ were added: 0.01, 0.05, 0.09, or 0.13 $\mu LL^{-1}$. Within each $O_3$ treatment, half of the plants were watered daily and half had water withheld 2 or 3 d per week. At 2-week intervals plants were harvested and divided into leaves, stems, and roots. Exposure to increasing concentrations of $O_3$ resulted in a linear decline in growth, but did not influence the allocation of biomass to roots, stems, and leaves. Ozone also delayed the onset of flowering. Weekly water stress periods of 2 or 3 d duration significantly inhibited the growth of soybean but did not alter the allocation of biomass or delay the onset of flowering. Water stress acted to close stomates and reduce the effective $O_3$ dose which resulted in a reduced percent reduction in growth that could be attributed to $O_3$ stress.

## 5604 Other Environmental Pollutant Effects

7489 **(AD-A—171583/8/XAB) Fundamental studies in the molecular basis of laser-induced retinal damage. Annual report, September 1982-August 1983.** Lewis. (Cornell Univ., Ithaca, NY (USA)). Sep 1983. 41p. NTIS, PC A03/MF A01.

This research led to major discoveries in two general areas. First, it was shown that there are a series of anionic activators of visual cells. These anionic activators turn on, in the dark, the enzymatic processes usually stimulated by light. Among these anionic activators is fluoride, the important additive in dental care. It is possible that the discovery of anionic activators will allow modulation of visual sensitivity and excitation. A second major advance was the development of a staining method that allows the direct observation with light microscopy of actin filaments in rod outer segments. This discovery will now allow viewing these important actin filaments in live cells under physiologically relevant experimental conditions. It will also allow for the development of new methods to probe pathological and damaged conditions in visual photoreceptor cells. The above discoveries are described in two separate sections, the first entitled Anionic Activators of Photoreceptor Cells in the Dark, and the second entitled Visualization of Actin in Photoreceptor Cells by Light Microscopy.

7490 **(AD-A—171644/8/XAB) Fundamental studies in the molecular basis of laser-induced retinal damage. Annual report, March 1980-February 1981.** Lewis. (Cornell Univ., Ithaca, NY (USA)). Feb 1981. 8p. NTIS, PC A02/MF A01.

Tunable-laser resonance Raman spectroscopy was one of the tunable-laser techniques proposed to investigate the molecular basis of retinal-damage problems. A principal problem in Raman spectroscopy is fluorescence that occurs at longer wavelengths (lower energies) than the incident laser wavelength. Significant progress was made in rejecting fluorescence from interfering with their Raman spectra. This progress is based on a fundamental difference between Raman scattering and fluorescence. This difference is simply the fact that fluorescence is observed at the same spectral frequencies no matter what the incident laser excitation, whereas the Raman scattering frequencies are tied to the incident laser frequency. It was proposed to apply such an innovation to pigmented eyes, since only then could the technique be applied with all its power to retinal damage problems at the molecular level. A significant effort expended to apply these new ideas in vivo in pigmented eyes, was quite successful.

7491 **(AD-A—171645/5/XAB) Fundamental studies in the molecular basis of laser-induced retinal damage. Annual report, February-September 1981.** Lewis. (Cornell Univ., Ithaca, NY (USA)). Sep 1981. 21p. NTIS, PC A02/MF A01.

Laser-spectroscopy experiments have focused on cones in the red-eared swamp turtle, Pseudemys scripta elegans. Choice of this system was based on the desire to correlate molecular data with the extensive data being collected on this system by Dr. Zwick in his studies on laser hazards at LAIR. Thus, a detailed collaborative effort was initiated on this system during the past year. The experiments resulted in important information that opens new avenues to explore fundamental molecular mechanisms of retinal damage with laser irradiation. Results of these experiments are summarized in the following sections: I. Elucidation of the role of oil droplets in the absorption of light by the turtle retina; II. A Selective Probe of Membrane Potentials in Turtle Cone Cells; III. Angstrom Resolution Light Microscopy of Photoreceptor Cells; IV. Identification and Selective Staining of Other Important Molecular Components of Photoreceptor Cells.

7492 **(AD-A—171663/8/XAB) Fundamental studies in the molecular basis of laser-induced retinal damage. Annual report, March 1979-February 1980.** Lewis. (Cornell Univ., Ithaca, NY (USA)). Apr 1980. 8p. NTIS, PC A02/MF A01.

Tunable-laser resonance Raman spectroscopy was one of the tunable-laser techniques we proposed to apply to investigate the molecular basis of retinal-damage problems. A principal problem in Raman spectroscopy is fluorescence that occurs at longer wavelengths (lower energies) than the incident laser wavelength. In photoreceptor-cell preparations, the principal fluorescence problem arises from accessory pigments in the pigment epithelium. Significant progress was made in rejecting fluorescence from interfacing with the Raman spectra. This progress is based on a fundamental difference between Raman scattering and fluorescence. This difference is simply the fact that fluorescence is observed at the same spectral frequencies no matter what the incident laser excitation, whereas the Raman scattering frequencies are tied to the incident laser frequency. It was proposed to apply such an innovation to pigmented eyes, since only then could the technique be applied with all its power to retinal damage problems at the molecular level. With this in mind, a significant effort was expended during the past year to apply these new ideas in vivo in pigmented eyes.

7493 **(AD-A—171684/4/XAB) Fundamental studies in the molecular basis of laser-induced retinal damage. Annual report, September 1981-August 1982.** Lewis. (Cornell Univ., Ithaca, NY (USA)). Sep 1982. 28p. NTIS, PC A03/MF A01.

This research led to new insights in the fundamental mechanisms involved in laser induced retinal damage and some of the fundamental work on these mechanisms lead to new and exciting avenues in the development of rapidly adjustable molecular light filters with important new possibilities for pulsed-laser eye protection. This report summarizes the significant progress of the past year: (1) Development and Fundamental Mechanism of a Rapidly Adjustable Molecular Filter for Pulsed Laser Eye Protection - this research direction resulted from our investigations on cones of the red-eared swamp turtle, Pseudemys scripta elegans. (2) The Optical Density of Turtle Oil Droplet Solutions - it is important both from a practical and fundamental point of view to determine the optical density of turtle oil-droplet suspensions. In view of the high optical densities in this system, tunable-laser resonance Raman spectroscopy, which is the only technique that has been able to provide high-resolution data, is the only technique that is potentially able to obtain the information. (3) Laser-Induced Molecular Alterations in Turtle Retina. (4) Light Driven Enzymatic Reactions in Photoreceptors. (5) Molecular Cytology of Rod Outer Segments.

7494 **(AD-A—171977/2/XAB) Retinal-hemorrhage thresholds for Q-switched neodymium-YAG laser exposures.** Blankenstein, M.F.; Zuclich; Allen, R.G.; Davis; Thomas, S.J. (Technology, Inc., San Antonio, TX (USA). Life Sciences Div.). Jul 1986. 5p. NTIS, PC A02/MF A01.

Published in Investigative Ophthalmology and Visual Science, Vol. 27, 1176-1179, Jul 1986.

Thresholds for retinal vitreal and contained hemorrhages were determined for 1064-nm laser light at 30-ns and 4-ns pulsewidths. Rhesus monkeys received graded exposures from a neodymium-YAG laser onto either the macular or extramacular region of the retina. Contained hemorrhages appeared as concentric-ring structures with white punctuate centers. The vitreal hemorrhage was characterized by the presence of choroidal blood in the vitreal chamber at the exposure site. The 30-ns contained-hemorrhage threshold (ED50) was 1.7 mJ on the macula and 2.1 mJ for an extramacular exposure. The 30-ns vitreal-hemorrhage macular threshold was 2.3 mJ, and the extramacular threshold was 6.6 Mj. The threshold for the 4-ns pulse widths to produce a hemorrhage (vitreal or contained) on the retina (macula or extramacular) was 340 uJ.

7495 **(PB—86-247970/XAB) Radiofrequency-radiation environment: environmental exposure levels and rf (radiofrequency) radiation-emitting sources.** Hankin, N.N. (Office of Radiation Programs, Washington, DC (USA)). Jul 1986. 94p. (EPA—520/1-85/014). NTIS, PC A05/MF A01.

The report summarizes the radiofrequency radiation environment to which the public is exposed. The contents consist of information on environmental levels of radiofrequency radiation produced by systems in common use such as AM and FM radio, VHF and UHF television, microwave communications, radar, and mobile radio. The exposure environment is discussed in terms of the system characteristics important to its creation.

7496 **(UCRL—50007-85, pp 1-9) Exposure guidelines for steady magnetic fields.** Miller, G. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

The powerful magnetic fields produced by many DOE energy-research experiments, including the Mirror Fusion Test Facility-B (MFTF-B) experiment at LLNL, necessitate the development of personnel-exposure guidelines for steady magnetic fields. A literature search and conversations with active researchers show that it is currently possible to develop preliminary exposure guidelines for steady magnetic fields. Further research is needed, however, to develop definitive exposure standards. An overview of the results of past research into the bioeffects of magnetic fields is presented, hazards that may be encountered by people with sickle-cell anemia or medical electronic and prosthetic implants are discussed, and the LLNL steady magnetic-field exposure guidelines are presented.

# 57 HEALTH AND SAFETY

*REFER ALSO TO CITATION(S) 6960*

7497 **(AD-A—171231/4/XAB) Hospitalizations for accidents and injuries in the US Navy. 4. A comparison of nuclear and conventionally powered surface ships. Interim report.** Bone, C.M.; Helmkamp, J.C. (Naval Health Research Center, San Diego, CA (USA)). Apr 1986. 16p. (NAVHLTHRSCHC—86-8). NTIS, PC A02/MF A01.

Occupational safety and health is of continuing concern to both private industry and the military. At present more than 2.5 million workdays are lost annually in the United States to injury and disease, with accidential injuries the leading cause of death and disability among men under age 35. Since the magnitude and severity of the risks of accidental injury depend upon the particular hazards associated with each occupation and work environment, and the protective and preventive measures in place to reduce such risks, interpretation of the relationship between these factors and host characteristics is needed to understand how they may contribute to accidents in the U.S. Navy. The objective of this study was to provide detailed analyses of accidental injury-related hospitalizations as a function of the work environment, determining if duty aboard nuclear powered ships was more or less hazardous than duty aboard conventionally powered ships of the same type.

# 58 GEOSCIENCES

## 5801 Geology And Hydrology

*REFER ALSO TO CITATION(S) 6509, 6745, 6746, 6747*

7498 **(DOE/ER/13391—1) Deep observation and sampling of the earth's continental crust (DOSECC). Final report.** (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). May 1985. Contract FG02-85ER13391. 23p. (CONF-8504280—Summ.). NTIS, PC A02. File Number DE87000782.

From Continental scientific drilling workshop; Houston, TX, USA (29 Apr 1985).

The need to validate and refine concepts regarding the structure, properties, and dynamic processes of the earth's continental crust through the use of the drill was the subject of the workshop sponsored by DOSECC, Inc. and held April 29 through May 1, 1985 in Houston, Texas and attended by more than 145 scientists. Scientific objectives and targets for a program of research drilling as part of basic studies of the continental lithosphere were discussed, with over 30 scientific proposals presented. Individual drill-

ing proposals were grouped under several themes; basement structures and deep continental basins, active fault zones, thermal regimes and fossil mineralized hydrothermal/magma systems.

7499 **(UCID—20740) Geological and geophysical investigations of Mid Valley.** McArthur, R.D.; Burkhard, N.R. (Lawrence Livermore National Lab., CA (USA)). Oct 1986. Contract W-7405-ENG-48. 89p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87002252.

We have conducted geological and geophysical studies of the southern portion of the Mid Valley area of the Nevada Test Site in an attempt to develop a new underground nuclear test area for LLNL that would accommodate tests up to 150 kt. We found that the basin is much deeper than we expected, which means that the yield that could be accommodated is larger than expected. In addition, this depth implies that the northern portion of the basin might also be usable as a test area. We have identified two problems that may limit the usefulness of Mid Valley for testing: (1) The upper portion of the alluvium is mostly tuffaceous and sloughs badly. Some hole stabilization may be needed to overcome this difficulty. (2) The static water level of about 500 m places an upper limit on the yield that can be accommodated if the working point must be the normal distance above the static water level.

## 5802 Geophysics

*REFER ALSO TO CITATION(S) 7268, 7518, 7842*

7500 **(CEA-CONF—8378) Aftershocks: an attempted analysis of their frequency and severity in view of risk assessment.** Mohammadioun, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). Aug 1985. 7p. (CONF-850809—84). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750283.

From 8. international conference on structural mechanics in reactor technology; Brussels, Belgium (19 Aug 1985).

A catalogue comprising some 30.000 strong and moderate-sized earthquakes with their associated aftershocks, collected worldwide, has been established for the purpose of studying time and magnitude distributions with engineering applications in mind. An attempt is made to model this data base using, notably, Poisson and Weibull relations. Preliminary results include regional variations in a coefficient evaluated by means of the magnitude law and the computed probability of occurrence of an aftershock of given magnitude within a given time after the main shock. A relationship is likewise shown to exist between maximum-density magnitudes and the maximum-density time intervals separating individual events. 13 refs., 3 figs.

7501 **(DOE/ER/10763—5) Depth to and concentrations of water in large bodies of silicic magma. Final report, September 1, 1980-April 30, 1986.** Anderson, A.T. Jr. (Chicago Univ., IL (USA)). Oct 1986. Contract AC02-80ER10763. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002211.

The objective was to determine the pre-eruption distribution of $H_2O$, $CO_2$, Cl and S in a large body of magma which yielded rhyolite - the Bishop Tuff, and to use the observed distribution to develop a conceptual model of the ascent, crystallization and stratification of the body of magma. The latter objective relies on eruption models and relevant field data to estimate total eruptive gas and the theory of heat conduction to estimate feasible amounts of crystallization.

7502 **(NUREG/CR—4753-Vol.1) Canadian seismic agreement. Annual report. Volume 1.** Wetmiller, R.J.; Lyons, J.A.; Shannon, W.E.; Munro, P.S.; Thomas, J.T.; Andrew, M.D.; Lamontagne, M.; Drysdale, J.A. (Geological Survey of Canada, Ottawa, Ontario; Canadian Commercial Corp., Ottawa, Ontario). Oct 1986. 39p. NTIS, PC A03/MF A01 - GPO. File Number TI87900072.

Activities undertaken by the Geophysics Division, Geological Survey of Canada (GSC) during the period June 1985 to June 1986 and supported in part by the NRC are described below under four headings; ECTN and portable network developments, datalab developments, strong motion network developments and earthquake activity.

7503 **Comparative response of alluvium to Hopkinson bar and gas gun loading.** Gaffney, E.S.; Brown, J.A. (Los Alamos National Lab., Los Alamos, NM). pp 621-626 of Shock waves in condensed matter. Gupta, Y.M. New York, NY; Plenum Press (1986). (CONF-850736—).

From American Physical Society topical conference on shock waves in condensed matter; Spokane, WA, USA (22 Jul 1985).

The authors have developed techniques for testing soils dynamically at strain rates ranging from about $10^2$ to $10^4$ $sec^{-1}$ in uniaxial strain using a Hopkinson bar. This admits direct comparison with data from gas gun tests where strain rates are in the range of $10^4$ to $10^5$ $sec^{-1}$. This in turn permits the separation of inertial effects from direct strain-rate effects. In order to assist in evaluation of the results the authors have also developed a one-dimensional microphysical model of soil.

## 5803 Mineralogy, Petrology, And Rock Mechanics

*REFER ALSO TO CITATION(S) 6568*

7504 **(LA-UR—86-3543) Serpentinization reaction pathways: implications for modeling approach.** Janecky, D.R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-8609134—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001765.

From Geochemical modelling workshop; Fallen Leaf Lake, CA, USA (14 Sep 1986).

Experimental seawater-peridotite reaction pathways to form serpentinites at 300°C, 500 bars, can be accurately modeled using the EQ3/6 codes in conjunction with thermodynamic and kinetic data from the literature and unpublished compilations. These models provide both confirmation of experimental interpretations and more detailed insight into hydrothermal reaction processes within the oceanic crust. The accuracy of these models depends on careful evaluation of the aqueous speciation model, use of mineral compositions that closely reproduce compositions in the experiments, and definition of realistic reactive components in terms of composition, thermodynamic data, and reaction rates.

7505 **Effects of wellbore liquids in propellant-based fracturing.** Cuderman, J.F. (Sandia National Labs., Albuquerque, NM 87185). pp 562-570 of Rock mechanics: Key to energy production. Littleton, CO; Society of Mining Engineers of AIME (1986). (CONF-860609—).

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

In situ experiments at the Department of Energy's Nevada Test Site (NTS) have extended the technology of propellant-based fracturing to include liquid-filled, uncased boreholes. Previous work had developed the technology for liquid-free, uncased wellbores. Test results show that fracturing behaviour is considerably more complex in liquid-filled boreholes than in the liquid-free case. Compared to liquid-free boreholes, liquid-filled boreholes have faster pressure risetimes and lower peak pressures, large hydraulic-type fractures propagating several meters beyond the end of the test zone, numerous oscillations in the pressure history, and variable types of fracturing within a single test region. Multiple fracturing is initiated in the wellbore of a fluid-filled borehole when the proper propellant mixture is used but, unlike fluid-free wellbores where up to eight fractures propagate, only one to three hydraulic and/or shear-type fractures propagate. Hydrodynamic effects involving liquid compression during borehole pressurization appear to be responsible for the differing phenomena observed in fluid-filled boreholes.

7506 **Seismic velocities in unconsolidated permafrost.** Zimmerman, R.W.; King, M.S.; Corwin, R.F. (Dept. of Mechanical Engineering, Univ. of California, Berkeley, CA 94720). pp 640 of Rock mechanics: Key to energy production. Littleton, CO; Society of Mining Engineers of AIME (1986). (CONF-860609—).

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

A model has been developed to relate the velocities of seismic waves in unconsolidated permafrost to the porosity and the extent of freezing. The permafrost is idealized as an assemblage of spherical quartz grains imbedded in a matrix which itself is composed of spherical water inclusions in ice. The theory of Kuster and Toksoz, based on wave-scattering considerations, is used to determine the effective elastic moduli, and hence the wave speeds. The model predicts Vp and Vs to be decreasing functions of both the porosity and the water/ice ratio, and Vp/Vs to be an increasing function of these two parameters. The theory has been applied to laboratory measurements of shear and compressional wave velocities in thirty-three permafrost samples from different sites in the North American Arctic. Although no direct measurements were made of the extents of freezing in these samples, the data are consistent with the predictions of the model. The theory can be used to infer the extent of freezing of the water in the pore spaces, based on knowledge of the porosity and either of the two wave speeds.

7507 **Quasi-static and dynamic arbitrary fracture propagation in jointed rock.** Shaffer, R.J.; Nilson, R.N.; Heuze, F.E.; Swift, R.P. (Lawrence Livermore National Lab.). pp 697-701 of Rock mechanics: Key to energy production. Littleton, CO; Society of Mining Engineers of AIME (1986). (CONF-860609—). Contract W-7405-ENG-48.

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

As part of the Unconventional Gas Program at the Lawrence Livermore National Laboratory, the authors are developing a model that allows for time-dependent tracking of the fluid front and flow pressures during the quasi-static or dynamic fracturing of jointed rocks. Application of the model is directed towards both short fast fractures (as in tailored pulse loading) and long hydraulically induced fractures (massive hydraulic fracturing). The thrust of this research is to determine crack extension characteristics due to specific joint systems and fluid properties and to correlate pumping records with crack behaviour in jointed systems.

## 5804 Geochemistry

7508 **(DOE/ER/13510—T2) Spectroscopic evidence for the chemical structure of algal kerogens.** Premovic, P.I.; Stojkovic, S.R.; Pugmire, R.J.; Woolfenden, W.R.; Rosenberger, H.; Scheler, G. (Utah Univ., Salt Lake City (USA). Dept. of Fuels Engineering; Nis Univ. (Yugoslavia). Dept. of Chemistry; Institute of General and Physical Chemistry, Belgrade (Yugoslavia); Utah Univ., Salt Lake City (USA). Dept. of Chemistry; Friedrich-Schiller-Universitaet, Jena (German Democratic Republic)). 1986. Contract FG02-86ER13510. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002459.

Two Permo-Carboniferous aliginites (one sample is from Torbane Hill in Scotland and the other is from South Africa) have been examined by high-resolution $^{13}C$ nuclear magnetic resonance employing the techniques of magic angle spinning and cross polarization. This examination has shown that these algal kerogens have predominantly aliphatic-type structure with a relatively high proportion of polymethylene chains and concomitant low total aromatic content. The aliphatic nature of alginite is further confirmed by both $^{1}H$ nuclear magnetic resonance spectroscopy employing the magic angle spinning technique as well as Fourier transform infrared analysis. This work and other organic geochemical studies suggest that algal geologic materials tend to preserve their basic aliphatic structure after burial despite relatively extensive diagenetic evolution under mild/moderate geological conditions. This interpretation is of much interest in connection with the problems of the origin and nature of Precambrian life. 32 refs., 3 figs.

7509 **(N—86-28535) Workshop on early crustal genesis: the World's oldest rocks.** Ashwal, L.D. (Lunar and Planetary Inst., Houston, TX (USA)). 1986. 187p. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—). NTIS, PC A09/MF A01.

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

Topics addressed include: a general review of Precambrain crustal evolution; geology and geochemistry of the Archean Craton in Greenland and Labrador; Precambrian crustal evolution in North and South America; and the field excursion to the Ameralik Fjord.

7510 (N—86-28535, pp vp) **Speculations on nature and extent of Archean basement in Labrador as indicated by Sr, Nd and Pb isotopic systematics of proterozoic intrusives.** Ashwal, L.D.; Wooden, J.L.; Emslie, R.F. (Geological Survey, Menlo Park, CA; Geological Survey of Canada, Ottawa, Ontario). 1986. NTIS, PC A09/MF A01. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—).

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

The Sm-Nd and Rb-Sr isotopic compositions of mid to late Proterozoic (approximately 1.6 to 1.1 Ga) massif-type anorthosites and mafic intrusives in the eastern Canadian shield are correlated with geographic location. Complexes in the Grenville province have positive epsilon sub Nd values and initial Sr-87/Sr-86 (I sub Sr) generally less than 0.703, suggesting derivation from depleted mantle. In Labrador, similar complexes close to or northwest of a line roughly corresponding to the Grenville Front have negative epsilon sub Nd values and I sub Sr 0.703. This contrast was intrepreted as reflecting either enriched mantle under the Nain Province, or contamination of the Nain intrusives with older crustal components. Lead isotopic compositions, however, favor the latter. The possibility of using these Proterozoic intrusives as tracers to characterize the nature and extent of older basement types in Labrador is discussed.

7511 (N—86-28535, pp vp) **Strontium and neodymium isotopic variations in early Archean gneisses affected by middle to late Archean high-grade metamorphic processes: West Greenland and Labrador.** Collerson, K.D.; Mcculloch, M.T.; Bridgwater, D.; Mcgregor, V.R.; Nutman, A.P. (Geological Museum, Copenhagen, Denmark; Atammik, Sukkertoppen, Greenland; Geological Survey of Greenland, Copenhagen, Denmark). 1986. NTIS, PC A09/MF A01. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—).

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

Relicts of continental crust formed more than 3400 Ma ago are preserved fortuitously in most cratons. The cratons provide the most direct information about crust and mantle evolutionary processes during the first billion years of Earth history. In view of their polymetamorphic character, these terrains are commonly affected by subsequent tectonothermal events. Hence, their isotope systematics may be severely disturbed as a result of bulk chemical change or local isotopic homogenization. This leads to equivocal age and source information for different components within these terrains. The Sr and Nd isotopic data are presented for early Archean gneisses from the North Atlantic Craton in west Greenland and northern Labrador which were affected by younger metamorphic events.

7512 (N—86-28535, pp vp) **Significance of the Sm-Nd isotopic systematics of the Akilia Association.** Gruau, G.; Nutman, A.; Jahn, B.M. (Geological Survey of Greenland, Copenhagen, Denmark). 1986. NTIS, PC A09/MF A01. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—).

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

Samarium-Neodymium analyses were carried out on fourteen samples of basic to ultrabasic metavolcanics from several enclaves of the Amitsoq gneisses (T = to or approximately 3,700 Ma). Field observations suggest that all the analyzed rocks belong

to the pre-Amitsoq Akilia Association. Consequently, a minimum age of 3,700 Ma is postulated for the emplacement of their protoliths. When all the data points are put together in a conventional isochron diagram, no clear isochron relationship can be discerned. However, the points seem to fall within a band broadly corresponding to an age of 3,600 Ma. The isotopic results are difficult to interpret satisfactorily. Two contrasting interpretations are offered and summarized: (1) data scatter as a result of open system behavior; and (2) data scatter due to a melange of data sets defining two distinct isochrons.

7513 (N—86-28535, pp vp) **Age and origin of gneisses south of Ameralik, between Kangimut-Sangmissoq and Qasigianguit.** Jones, N.W.; Moorbath, S.; Taylor, P.N. 1986. NTIS, PC A09/MF A01. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—).

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

Gneisses which crop out along the southern coast of Ameralik between Kangimut-sangmissoq and Qasigianguit (K-s-Q) are the subject of long-standing controversy concerning their relationship to the early Archean Amitsoq gneisses of the Godthaab district. On the basis of field observations, it was argued that gneisses at Kangimut-sangmissoq and Qasigianguit are correlatives of the early Archean Amitsoq gneisses. The data were reexamined and it is concluded that the K-s-Q gneisses represent an addition of substantially juvenile mantle-derived material to the Archean craton of West Greenland during the late Archean times. Some of the parent magmas have undergone interaction with older crust, as indicated by Pb isotope evidence for contamination with Amitsoq-derived Pb. However, the positive epsilon Nd(I) value for the K-s-Q gneisses firmly rules out any significant material contribution from the Amitsoq gneisses to the K-s-Q gneisses.

7514 (N—86-28535, pp vp) **Archean metamorphic sequence and surfaces, Kangerdlugssuaq Fjord, East Greenland.** Kays, M.A. 1986. NTIS, PC A09/MF A01. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—).

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

The characteristics of Archean metamorphic surfaces and fabrics of a mapped sequence of rocks older than about 3000 Ma provide information basic to an understanding of the structural evolution and metamorphic history in Kangerdlugssuaq Fjord, east Greenland. This information and the additional results of petrologic and geochemical studies have culminated in an extended chronology of Archean plutonic, metamorphic, and tectonic events. The basis for the chronology is considered, especially the nature of the metamorphic fabrics and surfaces in the Archean sequence. The surfaces, which are planar mineral parageneses, may prove to be mappable outside Kangerdlugssuaq Fjord, and if so, will be helpful in extending the events that they represent to other Archean sequences in east Greenland. The surfaces will become especially important reference planes if the absolute ages of their metamorphic assemblages can be determined in at least one location where strain was low subsequent to their recrystallization. Once an isochron is obtained, the dynamothermal age of the regionally identifiable metamorphic surface is determined everywhere it can be mapped.

7515 (N—86-28535, pp vp) **Pb isotopic evidence for early Archaean crust in South Greenland.** Taylor, P.N.; Kalsbeek, F. (Geological Survey of Greenland, Copenhagen, Denmark). 1986. NTIS, PC A09/MF A01. (NASA-CR—177306; NAS—1.26:177306; LPI-TR—86-04; CONF-8507139—).

From Workshop on early crustal genesis: the world's oldest rocks; Godthab, Greenland (21 Jul 1985).

The results of an isotopic remote sensing study focussed on delineating the extent of Early Archean crust north and south of the Nuuk area and in south Greenland is presented. Contamination of the Late Archean Nuk gneisses and equivalents by unradiogenic Pb uniquely characteristic of Amitsoq gneiss was detected as far south as Sermilik about 70 km south of Nuuk and only as far north as the mouth of Godthabsfjord. This study was extended to the southern part of the Archean craton and the adjoining Early Proterozoic Ketilidian orogenic belt where the Pb isotopes suggest several episodes of reworking of older uranium depleted continental crust. The technique of using the Pb isotope character of younger felsic rocks, in this case Late Archean and Early Proterozoic gneisses and granites to sense the age and isotopic character of older components, is a particularly powerful tool for reconstructing the evolutionary growth and development of continental crust.

## 5805 Oceanography

7516 (DOE/ER/60327—T1) **Airborne Oceanographic Lidar results. Spring removal experiments, April 1985.** Hoge, F. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). 21 Jun 1985. Contract AI01-85ER60327. 62p. NTIS, PC A04/MF A01. File Number DE87001670.

This document contains the preliminary results from the analysis of data acquired with the NASA Airborne Oceanographic Lidar (AOL) during the recent Spring Removal Experiment (SPREX). A total of four flights were made with the NASA P-3A aircraft in direct support of the SPREX studies. In addition, a single pass extending from the Sargasso Sea, across the Gulf Stream, and into Savannah was flown as the final leg of the ONR sponsored BIOWATT experiment. The relative distribution of surface temperature and the concentration of chlorophyll and phycoerythrin photopigments across the study area are provided. Also included are along track profiles of sea surface temperature and chlorophyll and phycoerythrin fluorescence emission for each of the individual flight lines. Both the chlorophyll and phycoerythrin laser induced fluorescence signals have been normalized by the water Raman backscatter signal and are each expressed as relative ratio's.

7517 (DOE/MC/20037—2231) **Relationship between ice island movement and weather conditions.** Yan, M.H. (Alaska Univ., Fairbanks (USA). Geophysical Inst.). Sep 1986. Contract AC21-83MC20037. 92p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87000652.

The object of this study is to find the relationship between ice island movement and synoptic weather conditions by using daily ice island position information and surface pressure maps. Trajectory analysis of an ice island for one year shows three types of movement episodes: (1) large movement in the southwest direction; (2) medium movement in two sequentially opposite directions; and (3) small random movement. Surface pressure maps show that an off-shore geostrophic wind component is a necessary pre-condition for the large and medium movements in the southwest direction. A high pressure system located near the North Pole then causes the movement in the southwest direction, whereas a low pressure system located near the North Pole causes the movement in the northeast direction. Results show that the speed ratios between the ice island and the geostrophic wind range from 1.0% to 1.5% for the large movement and 0.1% to 1.0% for the medium movement; the average angle ranges from 20 to 26° counterclockwise from the geostrophic wind direction to the ice island movement direction. A force balance shows that, for an equilibrium drifting state, a residual force must be included. 60 refs., 55 figs., 7 tabs.

# 64 PHYSICS I

7518 (PB—86-241510/XAB) **Physics through the 1990s: scientific interfaces and technological applications.** (National Research Council, Washington, DC (USA)). 1986. 286p. NTIS, PC A13/MF A01.

See also PB—86-241502; Library of Congress catalog card no. 85-32039.

The volume examines the scientific interfaces and technological applications of physics. Twelve areas are dealt with: biological physics--biophysics, the brain, and theoretical biology; the physics-chemistry interface--instrumentation, surfaces, neutron and synchrotron radiation, polymers, organic electronic materials; materials science; geophysics--tectonics, the atmosphere and oceans, planets, drilling and seismic exploration, and remote sensing; computational physics--complex systems and applications in basic research; mathe-

matics--field theory and chaos; microelectronics--integrated circuits, miniaturization, future trends; optical information technologies--fiber optics and photonics; instrumentation; physics applications to energy needs and the environment; national security--devices, weapons, and arms control; medical physics--radiology, ultrasonics, NMR, and photonics. An executive summary and many chapters contain recommendations regarding funding, education, industry participation, small-group university research and large facility programs, government agency programs, and computer database needs.

7519 **(PB—86-241536/XAB) Physics through the 1990s: an overview.** (National Research Council, Washington, DC (USA)). 1986. 206p. NTIS, PC A10/MF A01.

See also PB—86-241460; Library of Congress catalog card no. 85-30999.

The volume details the interaction of physics and society, and presents a short summary of the progress in the major fields of physics and a summary of the other seven volumes of the Physics through the 1990s series. Issues and recommended policy changes are described regarding funding, education, industry participation, small-group university research and large facility programs, government agency programs, and computer database needs. Three supplements report in detail on international issues in physics (the US position in the field, international cooperation and competition--especially on large projects, freedom for scientists, free flow of information, and education of foreign students), the education and supply of physicists (the changes in US physics education, employment and manpower, and demographics of the field), and the organization and support of physics (government, university, and industry research; facilities; national laboratories; and decision making). An executive summary contains recommendations for maintaining excellence in physics. A glossary of scientific terms is appended.

## 6401 Astrophysics And Cosmology

*REFER ALSO TO CITATION(S) 7638, 7649, 7743, 7743*

7520 **(AD-A—171633/1/XAB) First plasma wave observations at uranus.** Gurnett, D.A.; Kurth, W.S.; Scarf, F.L.; Poynter, R.L. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). 4 Jul 1986. 7p. NTIS, PC A02/MF A01.

Published in Science, Vol. 233, 106-109, 4 Jul 1986. Original contains color plates: all DTIc and NTIS reproductions will be in black and white.

Radio emissions from Uranus were detected by the Voyager 2 plasma wave instrument about 5 days before closest approach at frequencies of 31.1 and 56.2 kilohertz. About 10 hours before closest approach the bow shock was identified by an abrupt broadband burst of electrostatic turbulence at a radial distance of 23.5 Uranus radii. Once Voyager was inside the magnetosphere, strong whistler-mode hiss and chorus emissions were observed at radial distances less than about 8 Uranus radii, in the same region where the energetic-particle instruments detected intense fluxes of energetic electrons. Various other plasma waves were also observed in this same region. At the ring plane crossing, the plasma-wave instrument detected a large number of impulsive events that are interpreted as impacts of micrometer-sized dust particles on the spacecraft. The maximum impact rate was about 30 to 50 impacts per second, and the north south thickness of the impact region was about 4000 kilometers.

7521 **(AD-A—171925/1/XAB) Solar-burst precursors and energy buildup at microwave wavelengths.** Lang, K.R.; Willson, R.F. (Tufts Univ., Medford, MA (USA). Dept. of Physics and Astronomy). 1986. 5p. NTIS, PC A02/MF A01.

High-resolution microwave observations (VLA) of heating and magnetic triggering in coronal loops are summarized. Magnetic changes that precede solar eruptions on time scales of tens of minutes involve primarily emerging coronal loops and the interaction of two or more loops. Thermal cyclotron lines were detected in coronal loops, suggesting the presence of hot current sheets that enhance emission from relatively thin layers of enhanced temperature and constant magnetic field. These current sheets may play a role in the excitation of solar bursts. A filament-associated source with a high brightness temperature and steep radiation spectrum occurs above a region of apparently weak photospheric field. This source might be attributed to currents that enhance coronal magnetic fields. Compact (phi=5 sec) transient sources with lifetimes of 30 to 60 minutes were also detected in regions of apparently weak photospheric field. VLA observations of coronal loops are compared with simultaneous SMM-XRP observations in conclusion.

7522 **(AD-A—171985/5/XAB) Radio-wavelength observations of magnetic fields on active dwarf-M, RS CVN and magnetic stars.** Lang, K.R. (Tufts Univ., Medford, MA (USA). Dept. of Physics and Astronomy). 1986. 5p. NTIS, PC A02/MF A01.

The dwarf M stars YZ Canis Minoris and AD Leonis exhibit narrow band, slowly varying (hours) microwave emission that cannot be explained by conventional thermal radiation mechanisms. The dwarf M stars AD Leonis and Wolf 424 emit rapid spikes whose high brightness temperatures similarly require a nonthermal radiation process which could result from coherent mechanisms such as an electron-cyclotron maser or coherent-plasma radiation. If the electron-cyclotron maser emits at the second or third harmonic of the gyrofrequency, the coronal magnetic field strength H = 250 or 167 G and constraints on the plasma frequency imply an electron density of 6 x $10^9$/$cm^3$. Coherent-plasma radiation requires similar values of electron density but much weaker magnetic fields. Radio spikes from AD Leonis and Wolf 424 have rise times tau/sub R/ < 5 ms, indicating a linear size of L < 1.5 x $10^8$ cm, or less than 0.005 of the stellar radius. Although Ap magnetic stars have strong dipole magnetic fields, they exhibit no detectable gyroresonant radiation, suggesting that these stars do not have hot, dense coronae. The binary RS CVn star UX Arietis exhibits variable emission at 6 cm wavelength on time scales ranging from 30 s to more than one hour. The shortest variation implies a linear size much less than that of the halo observed by VLBI techniques, and most probably sizes smaller than those of the component stars. The observed variations might be due to absorption by a thermal plasma located between the stars.

7523 **(AD-A—172017/6/XAB) Shapes of the circumstellar silicate features.** Little-Marenin, I.R.; Price, S.D. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 8 Sep 1986. 3p. (AFGL-TR—86-0183). NTIS, PC A02/MF A01.

Around oxygen-rich stars, spectra of most long-period variables (LPV) show an excess infrared emission that is attributed to circumstellar silicate dust grains. These grains produce emission features at about 10 and 18-μm due to bending and stretching modes of Si0, respectively. It has been known (Forrest, Gillett and Stein 1975) that the spectral energy distribution of the 10-μm emission shows variations from star to star. With the availability of many IRAS Low Resolution Spectra (LRS) in the 9-22-μm region of M stars, the 10-μm feature was studied to determine its uniformity (or lack thereof). For this analysis, it was assumed that the 8-22-μm emission from these stars is produced by a) the stellar photosphere, b) a continuum emission from the dust grains, and c) a strongly wavelength-dependent dust grain emission term. By representing the first two terms with blackbody energy distributions and subtracting them from the observed spectrum, remaining is a strongly wavelength-dependent emission feature called the excess silicate or 10-μm emission.

7524 **(ESA-SP—41) Atmospheres of Saturn and Titan.** Rolfe, E.; Battrick, B. (European Space Agency, 75 - Paris (France)). Dec 1985. 319p. (ESA—86-96852; CONF-8509342—). NTIS, PC A14/MF A01.

From Conference on the atmospheres of Saturn and Titan; Alpabach, Austria (16 Sep 1985).

Sounding of the Saturn and Titan atmospheres by the Cassini probe was discussed. The chemistry and physics of their upper atmospheres, and the organic chemistry of Titan were considered. Complementary observations from Earth were treated.

7525 (ESA-SP—41, pp vp) **VLA-observations of Saturn: Can we do better from space.** Depater, I. Dec 1985. NTIS, PC A14/MF A01. (ESA—86-96852; CONF-8509342—).

From Conference on the atmospheres of Saturn and Titan; Alpabach, Austria (16 Sep 1985).

High resolution radio observations of Saturn obtained with the VLA at different wavelengths and different viewing aspects of the ring plane are discussed. Deficiencies of ground based observations in general and interferometric (VLA) observations in particular are emphasized. Two major problems are identified: the uncertainties of the absolute flux calibration, and the relatively low dynamic range obtained in ground-based planetary maps. Observations from space with a much smaller telescope (1 m) in orbit around Saturn can alleviate these problems and aid studies of Saturn's atmosphere and rings.

7526 **(LA—10819-T) Field reversing magnetotail current sheets: earth, Venus, and Comet Giacobini-Zinner.** McComas, D.J. (Los Alamos National Lab., NM (USA)). Sep 1986. Contract W-7405-ENG-36. 204p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87002229.

This dissertation examines the field reversing magnetotail current sheets at the earth, Venus, and Comet Giacobini-Zinner. In the near earth study a new analysis technique is developed to calculate the detailed current density distributions within the cross tail current sheet for the first time. This technique removes the effects of a variable sheet velocity by inverting intersatellite timings between the co-orbiting satellites ISEE-1 and -2. Case studies of three relatively geomagnetically quiet crossings are made; sheet thicknesses and peak current densities are ~1-5 x $10^4$ km and ~5-50 nA/$m^2$. Current density distributions reveal a high density central region, lower density shoulders, and considerable fine structure throughout. In the Venus study another new analysis technique is developed to reconstruct the average tail configuration from a correlation between field magnitude and draping angle in a large statistical data set. In the comet study, high resolution magnetic field and plasma electron data from the ICE traversal of Giacobini-Zinner are combined for the first time to determine the tail/current sheet geometry and calculate certain important but unmeasured local ion and upstream properties. Pressure balance across the tail gives ion temperatures and betas of ~1.2 x $10^5$ K and ~40 in the center of the current sheet to ~1 x $10^6$ K and ~3 in the outer lobes. Axial stress balance shows that the velocity shear upstream near the nucleus is >6 (~1 at ICE), and that a region of strongly enhanced mass loading (ion source rate ~24 times that upstream from lobes) exists upstream from the current sheet. The integrated downtail mass flux is ~2.6 x $10^{30}$ $H_2O$+/sec, which is only ~1% of the independently determined total cometary efflux. 79 refs., 37 figs.

7527 **(LBL—22224) Inflation and other cosmological aspects of superstring inspired models.** Gaillard, M.K. (Lawrence Berkeley Lab., CA (USA)). 22 Sep 1986. Contract AC03-76SF00098. 10p. (UCB-PTH—86/29; CONF-860701—31). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001721.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Investigations of the possibilities for inflation using the four dimensional models inspired by superstring theory is reported and discussed in the context of related work. 34 refs., 1 fig.

7528 **(MAP-HANDBK—8, pp vp) Limb-atmospheric infrared spectrum observed on the satellite Ohzora.** Matsuzaki, A.; Nakamura, Y.; Itoh, T. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

The Institute of Space and Astronautical Science (ISAS) launched the 9th scientific satellite Ohzora at 17:00 JST on February 14, 1984. This satellite bears the spectrometer, which measures the infrared spectrum of the solar radiation passing the limb atmosphere in the wavelength region of 2 to 10 m. The spectrometer is based on multichannel spectroscopy by using image sensors. Since the wavelength is scanned electronically, it can measure the spectrum unaffected by the satellite motion. A definite axis, i.e., the Z-axis of the satellite, which coincides to the optical axis of the spectrometer, is controlled to the direction of the Sun, and the finer control to introduce the solar light into the spectrometer is made with a 2-axes-controlled mirror. This solar tracking equipment is derived fast enough to measure the spectra in a moment after sunrise. The solar light introduced into the spectrometer is focused on the slits of the monochromators (f=100mm). For better altitude resolution, the horizontal slit is also used with the vertical slit, which is used for the separation of the dispersion. The dispersion light is detected with the pyroelectric array sensors. To obtain maximum dynamic range and spectral resolution, the three-stage polychromator is used.

7529 **(N—86-27946) ISEE-3 ULEWAT: flux tape description and heavy ion fluxes 1978-1984.** Mason, G.M.; Klecker, B. (Max-Planck-Institut fuer Physik und Astrophysik, Garching (Germany, F.R.)). Dec 1985. 325p. (NASA-CR—177269; EPA—86-96935). NTIS, PC A14/MF A01.

The ISEE ULEWAT FLUX tapes contain ULEWAT and ISEE pool tape data summarized over relatively long time intervals (1hr) in order to compact the data set into an easily usable size. (Roughly 3 years of data fit onto one 1600 BPI 9-track magnetic tape). In making the tapes, corrections were made to the ULEWAT basic data tapes in order to, remove rate spikes and account for changes in instrument response so that to a large extent instrument fluxes can be calculated easily from the FLUX tapes without further consideration of instrument performance.

7530 **(N—86-28019, pp vp) Distribution of solar wind implanted noble gases in lunar samples.** Kiko, J.; Kirsten, T. 1986. NTIS, PC A03/MF A01. (NASA-CR—177305).

From Workshop on past and present solar radiation: the record in meteoritic and lunar regolith material; Mainz, West Germany (3 Sep 1983).

The distribution of solar wind implanted noble gases in lunar samples depends on implantation energy, fluence, diffusion, radiation damage and erosion. It is known that at least the lighter rare gases are fractionated after implantation, but the redistribution processes, which mainly drive the losses, are not well understood. Some information about this one can get by looking at the concentration profiles of solar wind implanted He-4 measured by the Gas Ion Probe in single lunar grains. The observed profiles were divided in three groups. These groups are illustrated and briefly discussed.

7531 **(N—86-28275, pp vp) VLBI observations of 416 extragalactic radio sources.** Morabito, D.D.; Niell, A.E.; Preston, R.A.; Linfield, R.P.; Wehrle, A.E.; Faulkner, J. May 1986. NTIS, PC A10/MF A01. (NASA-CR—177229; JPL-TDA-PR—42-85; NAS—1.26:177229).

In Telecommunications and Data Acquisition Report.

The Deep Space Network is establishing a high-accuracy Very Long Base Interferometry (VLBI) celestial reference frame. Presented are the VLBI results of observations of 416 radio sources with declination north of -45 degrees which were conducted at frequencies of 2.3 GHz and 8.4 GHz. At 2.3 GHz 323 of 391 radio sources observed were detected with a fringe spacing of 3 milliarcsec and a detection limit of approximately 0.1 Jy. At 8.4 GHz, 278 of 416 radio sources were detected with a fringe spacing of 1 milliarcsec and a detection limit of approximately 0.1 Jy. This survey was conducted primarily to determine the strength of compact components at 8.4 GHz for radio sources previously detected with VLBI at 2.3 GHz. Compact extragalactic radio sources with strong correlated flux densities at both frequencies are used to form a high-accuracy reference frame.

7532 **(N—86-28811) International Workshop on Antarctic Meteorites.** Annexstad, J.O.; Schultz, L.; Waenke, H. (Lunar and Planetary Inst., Houston, TX (USA)). 1986. 122p. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—). NTIS, PC A06/MF A01.

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Topics addressed include: meteorite concentration mechanisms; meteorites and the Antarctic ice sheet; iron meteorites; iodine overabundance in meteorites; entrainment, transport, and concentration of meteorites in polar ice sheets; weathering of stony meteorites; cosmic ray records; radiocarbon dating; element distribution and noble gas isotopic abundances in lunar meteorites; thermoanalytical characterization; trace elements; thermoluminescence;

parent sources; and meteorite ablation and fusion spherules in Antarctic ice.

7533 (N—86-28811, pp vp) **Antarctic iron meteorites: An unexpectedly high proportion of falls of unusual interest.** Clarke, R.S. Jr. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

The inhabited and explored areas of Earth have contributed 725 iron meteorites, accounting for 28% of the 2611 authenticated meteorites known of all types. Observed fall statistics give a much different view of relative abundance. The 42 historic iron meteorite falls spanning 230 years suggests a frequency of one fall per 5.6 years and represents only 4.9% of the total 853 known falls. Antarctic iron meteorite recoveries offer promise of providing a new perspective on the influx problem. At least 42 iron meteorite specimens were found during the last 25 years by various field teams working in Antarctica. Most of these specimens were not described in detail, but the available data indicates that 21 separate falls are represented, 50% of the number of recovered specimens. Twelve of the 21 falls were both structurally classified and placed into chemical groups. They are listed in order of increasing structural complexity and/or Ni content.

7534 (N—86-28811, pp vp) **Mysterious iodine-overabundance in Antarctic meteorites.** Dreibus, G.; Waenke, H.; Schultz, L. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Halogen as well as other trace element concentrations in meteorite finds can be influenced by alteration processes on the Earth's surface. The discovery of Antarctic meteorites offered the opportunity to study meteorites which were kept in one of the most sterile environment of the Earth. Halogen determination in Antartic meteorites was compared with non-Antarctic meteorites. No correlation was found between iodine concentration and the weathering index, or terrestrial age. The halogen measurements indicate a contaminating phase rich in iodine and also containing chlorine. Possible sources for this contamination are discussed.

7535 (N—86-28811, pp vp) **Cosmic ray records in Antarctic meteorites.** Vogt, S.; Herpers, U.; Sarafin, R.; Signer, P.; Wieler, R.; Suter, M.; Woelfli, W. (Eidgenoessische Technische Hochschule, Zurich, Switzerland). 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

The cosmogenic radionuclides Be(10), Al(26), and Mn(53) and noble gases were determined in more than 28 meteorites from Antarctica by nuclear analytical techniques and static mass spectrometry, respectively. The summarized results are listed. The concentrations of Al(26) and Mn(53) are normalized to the repective main target elements and given in dpm/kg Si sub eq and dpm/kg Fe. The errors stated include statistical as well as systematical errors. For noble gas concentrations estimated errors are 5% and for isotopic ratios 1.5%. Cosmic ray exposure ages T sub 21 were calculated by the noble gas concentrations and the terrestrial residence time (T) on the basis of the spallogenic nuclide Al(26). The suggested pairing of the LL6 chondrite RKPA 80238 and RKPA 80248 and the eucrites ALHA 76005 and ALHA 79017 is confirmed not only by the noble gas data but also by the concentrations of the spallation produced radionuclides. Futhermore, ALHA 80122, clasified as an H6 chondrite, has a noble gas pattern which suggest that this meteorite belongs to the ALHA 80111 shower.

7536 (N—86-28811, pp vp) **Radiocarbon datings of Yamato meteorites.** Kigoshi, K.; Matsuda, E. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

The terrestrial ages of five Yamato Meteorites were measured by the content of cosmic-ray-produced carbon-14. Three Yamato Meteorites Y-74013, Y-74097, and Y-74136, which are all diogenites, were found at sites from one to two kilometers apart from each other. Evidence is presented for these three meteorites being a single meteorite. Also presented is a method adopted in the experimental procedure which includes a check for modern carbon contamination in the meteorites.

7537 (N—86-28811, pp vp) **Element distribution and noble gas isotopic abundances in lunar meteorite Allan Hills A81005.** Kraehenbuehl, U.; Eugster, O.; Niedermann, S. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Antarctic meteorite ALLAN HILLS A81005, an anorthositic breccia, is recognized to be of lunar origin. The noble gases in this meteorite were analyzed and found to be solar-wind implanted gases, whose absolute and relative concentrations are quite similar to those in lunar regolith samples. A sample of this meteorite was obtained for the analysis of the noble gas isotopes, including Kr(81), and for the determination of the elemental abundances. In order to better determine the volume derived from the surface correlated gases, grain size fractions were prepared. The results of the instrumental measurements of the gamma radiation are listed. From the amounts of cosmic ray produced noble gases and respective production rates, the lunar surface residence times were calculated. It was concluded that the lunar surface time is about half a billion years.

7538 (N—86-28811, pp vp) **Trace elements in Antarctic meteorites: weathering and genetic information.** Lipschutz, M.E. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Antarctic meteorite discoveries have created great scientific interest due to the large number of specimens recovered (approximately 7000) and because included are representatives of hitherto rare or unknown types. Antarctic meteorites are abundant because they have fallen over long periods and were preserved, transported, and concentrated by the ice sheets. The weathering effects on the Antarctic meteorites are described. Weathering effects of trace element contents of H5 chondrites were studied in detail. The results are examined. The properties of Antarctic finds and non-Antarctic falls are discussed.

7539 (N—86-28811, pp vp) **Terrestrial and exposure histories of Antarctic meteorites.** Nishiizumi, K. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Records of cosmogenic effects were studied in a large suite of Antarctic meteorites. The cosmogenic nuclide measurements together with cosmic ray track measurements on Antartic meteorites provide information such as exposure age, terrestrial age, size and depth in meteoroid or parent body, influx rate in the past, and pairing. The terrestrail age is the time period between the fall of the meteorite on the Earth and the present. To define terrestrial age, two or more nuclides with different half-lives and possibly noble gases are required. The cosmogenic radionuclides used are C-14, Kr-81, Cl-36, Al-26, Be-10, Mn-53, and K-40.

7540 (N—86-28811, pp vp) **Weathering effects and solar components in two Allen Hills chondrites.** Padia, J.T.; Rao, M.N. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Two Allen Hills chondrites, ALHA 77252 and ALHA 77215 belonging to the L-group were studied by stepwise heating mass spectrometric methods for elemental and isotopic composition of noble gases. The results are discussed.

7541 (N—86-28811, pp vp) **Terrestrial ages of Antarctic meteorites: implications for concentration mechanisms.** Schultz, L. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Antarctic meteorites differ from meteorites fallen in other places in their mean terrestrial ages. Boeckl estimated the terrestrial half-life for the disintegration of stone meteorites by weathering under the climatic conditions of the Western United States to be about 3600 years. Antarctic meteorites, however, have terrestrial ages up to 70000 years, indicating larger weathering half-lives. The terrestrial ages of meteorites are determined by their concentration of cosmic-ray-produced radionuclides with suitable half-lives (C-14, Al-26, and Cl-36). These radionuclides have yielded reliable ages for the Antarctic meteorites. The distribution of terrestrial ages of Allan Hills and Yamato meteorites are examined.

7542 (N—86-28811, pp vp) **Thermoluminescence and Antarctic meteorites.** Sears, D.W.G.; Hasan, F.A. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

The level of natural thermoluminescence (TL) in meteorites is the result of competition between build-up, due to exposure to cosmic radiation, and thermal decay. Antarctic meteorites tend to have lower natural TL than non-Antarctic meteorites because of their generally larger terrestrial ages. However, since a few observed falls have low TL due to a recent heating event, such as passage within approximately 0.7 astronomical units of the Sun, this could also be the case for some Antarctic meteorites. Dose rate variations due to shielding, heating during atmospheric passage, and anomalous fading also cause natural TL variations, but the effects are either relatively small, occur infrequently, or can be experimentally circumvented. The TL sensitivity of meteorites reflects the abundance and nature of the feldspar. Thus intense shock, which destroys feldspar, causes the TL sensitivity to decrease by 1 to 2 orders of magnitude, while metamorphism, which generates feldspar through the devitrification of glass, causes TL sensitivity to increase by a factor of approximately 10000. The TL-metamorphism relationship is particularly strong for the lowest levels of metamorphism. The order-disorder transformation in feldspar also affect the TL emission characteristics and thus TL provides a means of paleothermometry.

7543 (N—86-28811, pp vp) **Thermoluminescence of Antarctic meteorites: a rapid screening technique for terrestrial age estimation, pairing studies and identification of specimens with unusual prefall histories.** Sutton, S.R.; Walker, R.M. 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

Thermoluminescence (TL) is a promising technique for rapid screening of the large numbers of Antarctic meteorites, permitting identification of interesting specimens that can then be studied in detail by other, more definite techniques. Specifically, TL permits determination of rough terrestrial age, identification of potential paired groups and location of specimens with unusual pre-fall histories. Meteorites with long terrestrial ages are particularly valuable for studying transport and weathering mechanisms. Pairing studies are possible because TL variations among meteorites are large compared to variations within individual objects, especially for natural TL. Available TL data for several L3 fragments, three of which were paired by other techniques, are presented as an example of the use of TL parameters in pairing studies. Additional TL measurements, specifically a blind test, are recommended to satisfactorily establish the reliability of this pairing property. The TL measurements also identify fragments with unusual pre-fall histories, such an near-Sun orbits.

7544 (N—86-28811, pp vp) **Meteoritic ablation and fusion spherules in Antarctic ice.** Thiel, K.; Peters, J.; Raisbeck, G.M.; Yiou, F. (Centre National de la Recherche Scientifique, Orsay, France). 1986. NTIS, PC A06/MF A01. (NASA-CR—177309; NAS—1.26:177309; LPI-TR—86-01; CONF-8507140—).

From International workshop on Antarctic meteorites; Mainz, F.R. Germany (10 Jul 1985).

In the course of two Antarctic expeditions in 1980/1981 and 1982/1983 approximately 4 metric tons of documented ice samples were collected from the Atka Bay Ice Shelf, Antarctica, and subsequently shipped for cosmic dust studies. After filtration of the melt water, approximately 700 Antarctic spherules (AAS) in the size range of 5 to 500 microns were handpicked from the filter residue under optical microscopes. For the chemical investigation of single dust grains the following techniques were applied: scanning electron microscopy (SEM), X-ray analysis (EDAX), instrumental neutron activation analysis (INAA), laser microprobe mass analysis (LAMMA), and accelerator mass spectroscopy (AMS). For more than 95% of the total mass the bulk and trace elements were determined in single grain analyses using EDAX, INAA, and LAMMA. The element pattern of the dust particles was compared with that of typical terrestrial material and meteoritic matter. The majority of the spherules exhibited elemental compositions compatible with meteoritic element patterns.

7545 (N—86-28892) **Comparison of star formation characteristics in different types of irregular galaxies. Final technical report.** Lamb, S.S.; Hunter, D.A.; Gallagher, J.S.I. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). Jul 1986. 5p. (NASA-TM—88779; NAS—1.15:88779). NTIS, PC A02/MF A01.

Two regions of recent star formation in blue irregular galaxies were observed with the IUE in the short wavelength, low dispersion mode. The spectra indicates that the massive star content is similar in these regions and is best fit by massive stars formed in a burst and now are approximately 2.5 to 3.0 million years old.

7546 (N—86-28896) **Metastable carbon in two chondritic porous interplanetary dust particles.** Rietmeijer, F.J.M.; Mackinnon, I.D.R. (Lockheed Engineering and Management Services Co., Inc., Houston, TX (USA)). 1986. 15p. (NASA-CR—177200; NAS—1.26:177200). NTIS, PC A02/MF A01.

An understanding of carbonaceous matter in primitive extraterrestrial materials is an essential component of studies on dust evolution in the interstellar medium and the early history of the Solar System. Analytical Electron Microscopy (AEM) on carbonaceous material in two Chondritic Porous (CP) aggregrates is presented. The study suggests that a record of hydrocarbon carbonization may also be preserved in these materials.

7547 (N—86-28897) **Limits on coronal material in normal galaxies. Final technical report, 1 May 1982-30 April 1986.** Mccammon, D. (Wisconsin Univ., Madison (USA)). Jul 1986. 38p. (NASA-CR—177195; NAS—1.26:177195). NTIS, PC A03/MF A01.

Measurements of the X-ray surface brightness of a face on disk galaxy M101 have previously been used to place upper limits on the power radiated by a hot corona. Such analysis contrains the effective density of the disk; either it must be so low that the remnants drive a fast hot wind (low radiated power) or so high that the remnant temperature at overlap is low (low X-ray power). These X-ray measurements are here used to constrain the properties of the population of supernova remnants evolving in the disk. This adds a further constraint since young remnants evolving in higher density radiate more of their energy in X-rays, whether or not they eventually overlap to generate a hot corona. The strength of this second limit depends strongly on the density history of the remnants and on the assumed supernova rate. For evaporative evolution the analysis rules out McKee and Ostriker ISM model in particular and evaporative evolution in general unless the supernova rate is at least several times lower than current expectations. For standard

Sedov evolutions, the density limit marginally admits evolution in 0.2 cu m, a popular alternative to the McKee and Ostriker model.

7548 (N—86-28898) **Molecular clouds in the outer galaxy 1: far infrared observations.** Mead, K.N.; Kutner, M.L.; Evans, N.J. II; Harvey, P.M.; Wilking, B.A. (Texas Univ., Austin (USA)). 1986. 17p. (NASA-CR—177127; NAS—1.26:177127). NTIS, PC A02/MF A01.

From the Kuiper Airborne Observatory, far infrared emission were detected from 4 molecular clouds in the outer galaxy. Eleven areas in 6 clouds were observed at 50 and 100 microns. The far-infrared luminosities indicate the presence of stars with spectral types ranging from B3 to O7. Therefore, despite the fact that these clouds have lower CO line temperatures than comparable clouds in the inner galaxy, they are giving birth to massive stars.

7549 (N—86-28900) **Magnetic properties of Jupiter's tail at distances from 80-7500 Jovian radii.** Goldstein, M.L.; Lepping, R.P.; Sittler, E.C.,JR. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Sep 1984. 64p. (NASA-TM—86159; NAS—1.15:86159). NTIS, PC A04/MF A01.

A detailed study of the magnetic field data from both Voyagers 1 and 2 has revealed several interesting properties of the near and distant Jovian magnetotail. During the first encounter, as Voyager 1 passed between 80 and 140 R sub J from Jupiter in the near tail, the spacecraft was almost entirely in the northern lobe magnetic field. The frequency spectrum of magnetic fluctuation in this region cannot be characterized by a power law and does not appear to be turbulent. The distant tail spectra from Voyager 2 are compared with similar spectra obtained from Voyager 1 when it was in near radial alignment with Voyager 2. Although the gross properties of the tail and solar wind fields in most respects differ considerably, the shape and power levels of the spectra of the magnetic fluctuations are very similar, especially between .0001 and .001 Hz. At lower frequencies (.00001 to .0001 Hz) the spectra of magnetic helicity do differ.

7550 (N—86-28904) **Nineteenth International Cosmic Ray Conference papers. General index, volume 10.** Jones, F.C. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Jul 1986. 104p. (NASA-CP—2376-VOL-10; NAS—1.55:2376-VOL-10; CONF-850883—Vol.10). NTIS, PC A$200.00/MF $200.00.

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

These volumes contain papers submitted for presentation at the 19th International Cosmic Ray Conference held on the campus of the University of California, San Diego, in La Jolla, CA, Aug. 11-23, 1985. The present volume contains a complete author index for volumes 1 through 9 and a list of the names and addresses of all those who attended the conference.

7551 (N—86-28905) **Multidisciplinary study of planetary, solar and astrophysical radio emissions. Final technical report.** Gurnett, D.A.; Calvert, W.; Fielder, R.; Goertz, C.; Grabbe, C.; Kurth, W.; Mutel, R.; Sheerin, J.; Mellott, M.; Spangler, S. (Iowa Univ., Iowa City (USA)). Jul 1986. 39p. (NASA-CR—177166; NAS—1.26:177166). NTIS, PC A03/MF A01.

Combination of the related fields of planetary, solar, and astrophysical radio emissions was attempted in order to more fully understand the radio emission processes. Topics addressed include: remote sensing of astrophysical plasma turbulence; Alfven waves; astrophysical shock waves; surface waves; very long base interferometry results; very large array observations; solar magnetic flux; and magnetohydrodynamic waves as a tool for solar corona diagnostics.

7552 (N—86-29301, pp vp) **Convection pattern morphology and variations (invited review).** Heelis, R.A. Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

A fairly straightforward consideration of the interaction between a southward interplanetary magnetic field and the Earth's magnetic field will result in the prediction of a two cell convection pattern in the high latitude ionosphere. This is shown schematically where the antisunward flow at high latitudes results from the application of the solar wind electric field to the ionosphere and the return sunward flow results from an electric field generated in the plasma sheet to ensure continuity. This convection pattern can be quite easily characterized in terms of the radius of the approximately circular region containing the antisunward flow, called the polar cap and the maximum potential difference applied across this region. The convection pattern described is at least understandable in terms of solar wind/magnetosphere interaction in which open field lines are recirculated in the polar cap and a viscous interaction process exists near the flanks of the magnetosphere's equatorial plane giving rise to the lower latitude convection cells.

7553 (N—86-29301, pp vp) **Three dimensional model of the Venusian thermosphere with superrotation.** Stevens-Rayburn, D.R.; Mayr, H.G.; Harris, I. (Applied Research Corp., Landover, MD). Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

An improved three dimensional spectral model of the thermosphere of Venus is described. The model solves the Navier-Stokes equations and includes nonlinear effects for an arbitrary number of atmospheric species. A two dimensional axisymmetric model of the superrotation of the thermosphere is also presented. This model addresses the Pioneer-Venus mission finding, which suggested the thermospheric rotation rate to be much higher than that of the planet as seen from the asymmetric distribution of hydrogen and helium. Both models include the effects of an anisotropic eddy diffusion that is consistent with atmospheric mixing length theory.

7554 (N—86-29744) **Carbonaceous chondrites: early irradiation and Pu-244 fission records. Final technical report, 1 February 1975-31 January 1983.** Macdougall, J.D. (Scripps Institution of Oceanography, La Jolla, CA (USA)). 1983. 8p. (NASA-CR—177288; NAS—1.26:177288). NTIS, PC A02/MF A01.

The carbonaceous meteorites were studied. The studies which were conducted have evolved from investigations of early irradiation to mineralogic and petrologic studies of refractory inclusions and to an examination of the time scales of alteration processes on the parent bodies. The attached listing of papers and abstracts provide the details.

7555 (N—86-29745) **Numerical studies of collapsing interstellar clouds. Final technical report.** Bodenheimer, P.H.; Villere, K.R.; Black, D.C. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). Feb 1986. 21p. (NASA-TM—88771; NAS—1.15:88771). NTIS, PC A02/MF A01.

Numerical simulation of the structure and evolution of interstellar clouds was initiated. Steps were taken toward an integrated treatment of the dynamical, thermal, and chemical processes entering model calculations. A detailed study was made of radiative transfer in molecular lines to allow model predictions to be tested against empirical data. The calculations have successfully reproduced and explained several observed cloud properties, including abundances of complex molecular species and the apparent depletion of CO in dense cores.

7556 (N—86-29756) **Simulation study of two major events in the heliosphere during the present sunspot cycle.** Akasofu, S.I.; Fillius, W.; Sun, W.; Fry, C.; Dryer, M. (Alaska Univ., Fairbanks (USA)). 1985. 48p. (NASA-CR—176943; NAS—1.26:176943). NTIS, PC A03/MF A01.

The two major disturbances in the heliosphere during the present sunspot cycle, the event of June to August, 1982, and the event of April to June, 1978, are simulated by the method developed by Hakamada and Akasofu (1982). Specifically, an attempt

was made to simulate the effects of six major flares from three active regions in June and July, 1982, and April and May, 1978. A comparison of the results with the solar wind observations at Pioneer 12 (approximately 0.8 au), ISEE-3 (approximately 1 au), Pioneer 11 (approximately 7 to 13 au) and Pioneer 10 (approximately 16 to 28 au) suggests that some major flares occurred behind the disk of the sun during the two periods. The method provides qualitatively some information as to how such a series of intense solar flares can greatly disturb both the inner and outer heliospheres. A long lasting effect on cosmic rays is discussed in conjunction with the disturbed heliosphere.

7557 (N—86-30610) **Astrophysical materials science: theory. Final technical report.** Ashcroft, N.W. (Cornell Univ., Ithaca, NY (USA)). 1984. 13p. (NASA-CR—177021; NAS—1.26:177021). NTIS, PC A02/MF A01.

A method of structural expansions for use in determining the equation of state of metallic hydrogen (and indeed other metals) up to the 4th order in the perturbation theory was developed. The electrical and thermal transport properties of the planetary interior of Jupiter were calculated. The nature of the interaction between molecules at short range and the importance of multicenter terms in arriving at an adequate description of the thermodynamic functions of condensed molecular hydrogen were also investigated.

7558 (N—86-30611) **Evolution of primordial gas clouds. Final technical report, 15 February 1984-28 February 1986.** Bodenheimer, P.H. (California Univ., Santa Cruz (USA)). Feb 1986. 23p. (NASA-CR—176959; NAS—1.26:176959). NTIS, PC A02/MF A01.

The dynamical, chemical, and thermal evolution of zero-metal gas clouds was modeled to study conditions of star formation in the early universe. Numerical results are given for the collapse of spherical clouds of mass 1000 and 50000 solar mass. Cooling by H2 lines and by photons emitted in H + e(-) yields H(-) = h (sup nu) maintains collapse until formation of an equilibrium protostellar core of mass 0.02 solar mass. The cooling by photons produced with H is essential for low mass star formation. If the cloud is fragmented, the evolution of the pieces is similar to that of the parent cloud, but the equilibrium core has larger density and mass.

7559 (N—86-30621) **Preliminary development of a global 3-D magnetohydrodynamic computational model for solar wind-cometary and planetary interactions.** Stahara, S.S. (Resource Management Associates, Lafayette, CA (USA)). May 1986. 20p. (NASA-CR—177090; NAS—1.26:177090; RMA-TR—101). NTIS, PC A02/MF A01.

This is the final summary report by Resource Management Associates, Inc., of the first year's work under Contract No. NASW-4011 to the National Aeronautics and Space Administration. The work under this initial phase of the contract relates to the preliminary development of a global, 3-D magnetohydrodynamic computational model to quantitatively describe the detailed continuum field and plasma interaction process of the solar wind with cometary and planetary bodies throughout the solar system. The work extends a highly-successful, observationally-verified computational model previously developed by the author, and is appropriate for the global determination of supersonic, super-Alfvenic solar wind flows past planetary obstacles. This report provides a concise description of the problems studied, a summary of all the important research results, and copies of the publications.

7560 (N—86-30624) **Cosmic x-ray physics. Semiannual status report, 1 January-30 June 1986.** Mccammon, D.; Cox, D.P.; Kraushaar, W.L.; Sanders, W.T. (Wisconsin Univ., Madison (USA)). Jul 1986. 16p. (NASA-CR—177227; NAS—1.26:177227). NTIS, PC A02/MF A01.

The analysis of the beryllium-filtered data from Flight 17.020 was completed. The data base provided by the Wisconsin diffuse x-ray sky survey is being analyzed by correlating the B and C band emission with individual velocity components of neutral hydrogen. Work on a solid state detector to be used in high resolution spectroscopy of diffuse or extend x-ray sources is continuing. A series of 21 cm observations was completed. A paper on the effects of process parameter variation on the reflectivity of sputter-deposited tungsten-carvon multilayers was published.

7561 (N—86-30625) **Study of (OI) 63.2 and 145.5 micron emission from M17 and SGR A from the Lear jet. Final report, 1 October 1982-31 March 1986.** Melnick, G.G. (Smithsonian Astrophysical Observatory, Cambridge, MA (USA)). Mar 1986. 27p. (NASA-CR—177015; NAS—1.26:177015). NTIS, PC A03/MF A01.

The Lear Jet Observatory was used to observe the 157.7 micron (C II) line from the galactic H II regions W3 and W51. These measurements established a lower limit in the 157.7 micron line for solar luminosity of 360 from W3, assuming adistance of 2 kpc, and a solar luminosity of 4100 from W51, assuming a distance of 7 kpc. The data indicated that the CII/far infrared continuum ratio for both W3 and W51 were within the range found for other galactic H II regions.

7562 (N—86-31409, pp vp) **Chronology and isotopic geochemistry of Apollo 14 basalts and Skaergard Gabbro, Eastern Greenland.** Dasch, E.J. Jul 1986. NTIS, PC A99/MF E03. (NASA-CR—171931; NAS—1.26:171931).

In NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1985.

Work completed on Apollo 14 basalts has been published. The two dates obtained from these rocks comprised the oldest and two of the three oldest ages (4.1 and 4.3 billion years) known for lunar maria basalts; thus their ages are important in understanding the moon's earliest history. Owing to the antiquity of these rocks, two more fragments have been dated as part of a second ASEE/NASA SFF program. The new ages are 3.95 and 4.12 billion years, thus further establishing and amplifying the earlier results. This work, although perhaps more interesting for its chronologic information, was begun as a test of chemical and petrographic models. Fragments of Apollo basalt were placed into five categories, based on petrologic and chemical, especially rare-earth element, composition. Isotopic studies were begun in an attempt to determine if the five groups of basalts were related by age or initial isotopic composition (isotopic composition of lava at time of extrusion). Although a few of the representatives of the five groups have the same age and/or initial strontium-isotopic composition, within the analytical uncertainties, most apparently are unrelated. Petrologic implications of these data will be published in an appropriate journal.

7563 (N—86-31466) **Observations of far-infrared molecular emission lines from the Orion molecular cloud. Ph.D. Thesis.** Viscuso, P.J. (Cornell Univ., Ithaca, NY (USA)). Aug 1986. 236p. (NASA-CR—176876; NAS—1.26:176876; CRSR—849). NTIS, PC A11/MF A01.

Ph.D. Thesis.

The Orion Nebula was the subject of intensive study for over one hundred years. Recently, several far infrared transitions among the low-lying levels of OH were observed toward IRc2. The OH is thought to be abundant, and plays an important role in the chemical evolution of shock and post-shock regions. The OH emission serves as a sensitive probe of the temperature and density for the shock-processed gas. A rigorous treatment of the radiative transfer of these measured transitions was performed using the escape probability formalism. From this analysis, the temperature of the OH-emitting region was determined to be on the order of 40K. This suggests that the gas is part of the post-shock gas that has cooled sufficiently, most likely by way of radiative cooling by CO. Such cooling from shock temperatures of several degrees can be accomplished in 100 years. A molecular hydrogen density of 3 million/cubic cm and an OH column density of 1.0 x 10 to the 17th / sq cm is found. The beam filling factor is determined to be 36%.

7564 (N—86-31467) **Study of the discrepant QSO x-ray luminosity function from the HEAO-2 data archive. Final technical report.** Margon, B. (Washington Univ., Seattle (USA)). 1986. 64p. (NASA-CR—176875; NAS—1.26:176875). NTIS, PC A04/MF A01.

Sensitive x-ray information for approximately 90 previously uncataloged Quasi-Stellar Objects (QSOs) in the redshift range 1.8 is less than or equal to z which is less than or equal to 3. Even with the longest esixting Einstein Observatory x-ray exposures, only 25% of these objects are positively detected in x-rays. The data

were used to investigate the ensemble x-ray properties of high redshift QSOs, and the QSO population in general.

7565 (N—86-31470) **EX-111 thermal emission from hot white dwarfs: the suggested He abundance-temperature correlation. EX-112: the unique emission line white dwarf star GD 356. Semiannnual status report, 1 December 1985-1 June 1986.** Shipman, H.L. (Delaware Univ., Newark (USA)). Aug 1986. 110p. (NASA-CR—176866; NAS—1.26:176866). NTIS, PC A06/MF A01.

Progress in the EXOSAT data analysis program is reported. EXOSAT observations for four white dwarfs (WD1031-115, WD0004+330, WD1615-154, and WD0109-264) were obtained. Counting rates were unexpectedly low, indicating that these objects have a substantial amount of x-ray absorbing matter in their photospheres. In addition, soft x-ray pulsations characterized by a 9.25 minute cycle were discovered in the DA white dwarf V471 Tauri. A residual x-ray flux from the K dwarf companion can be seen during the white dwarf eclipse at orbital phase 0.0. Pronounced dips in the soft x-ray light curve occur at orbital phases 0.15, 0.18, and 0.85. The dips may be correlated with the triangular Lagrangian points of the binary orbit. Smaller dips at phases near the eclipse may be associated with cool loops in the K star corona. Data for the white dwarf H1504+65 was also analyzed. This object is particularly unusual in that its photoshere is devoid of hydrogen and helium. Finally, existing data on the white dwarf Sirius B were analyzed to see what constraints from other data can be placed on the properties of this star. Interrelationships between radius, rotational velocity, and effective temperature were derived.

7566 (N—86-31478) **Studies of the aurorally-induced ultraviolet emissions on the nightside of Venus. Report, 1 January 1985-31 March 1986.** Fox, J.L. (State Univ. of New York, Stony Brook (USA)). Mar 1986. 23p. (NASA-CR—177004; NAS—1.26:177004). NTIS, PC A02/MF A01.

The effect of a monoenergetic flux of electrons on a model atmosphere of the nightside thermosphere of Venus was examined. The neutral model chosen is that of Hedin for high solar activity and 165 degrees solar zenith angle. The model is based on measurements made by the Pioneer Venus Orbiter Neutral Mass Spectrometer. Four species were included in the calculation: CO2, O, CO, and N2. The numerical method that was chosen for energy deposition of the primary electrons is the continuous slowing down approximation. The secondary electron distribution was computed using the empirically determined shape of the differential cross section.

7567 (N—86-31483) **Nineteenth International Cosmic Ray Conference. Conference papers: Invited rapporteur, highlight, miscellaneous, volume 9.** Jones, F.C. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Feb 1986. 555p. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9). NTIS, PC A$200.00/MF $200.00.

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Invited talks, rapporteur talks, and highlight talks are included. Topics of the invited and highlight talks include astrophysical jets, gamma-ray line astronomy, cosmic rays and gamma rays in astrophysics, the early universe, elementary particle physics, solar flares and acceleration of energetic particles, cosmogenic nuclei, extragalactic astronomy, composition of solar flare particles, very high energy gamma ray sources, gamma-ray bursts, shock acceleration in the solar wind, cosmic rays in deep underground detectors, spectrum of cosmic rays at 10 to the 19th power eV, and nucleus-nucleus interactions.

7568 (N—86-31483, pp vp) **Cosmic jets.** Rees, M.J. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The evidence that active galactic nuclei produce collimated plasma jets is summarised. The strongest radio galaxies are probably energised by relativistic plasma jets generated by spinning black holes interacting with magnetic fields attached to infalling matter. Such objects can produce e(+)-e(-) plasma, and may be relevant to the acceleration of the highest-energy cosmic ray primaries. Small-scale counterparts of the jet phenomenon within our own galaxy are briefly reviewed.

7569 (N—86-31483, pp vp) **Gamma-ray line astrophysics.** Lingenfelter, R.E.; Ramaty, R. (California Univ., La Jolla). Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Recent observations of gamma-ray line emission from solar flares, gamma-ray bursts, the galactic center, the interstellar medium and the jets of SS433 are reviewed. The implications of these observations on high energy processes in these sources are discussed.

7570 (N—86-31483, pp vp) **Constraints on galaxy formation theories.** Szalay, A.S. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The present theories of galaxy formation are reviewed. The relation between peculiar velocities, temperature fluctuations of the microwave background and the correlation function of galaxies point to the possibility that galaxies do not form uniformly everywhere. The velocity data provide strong constraints on the theories even in the case when light does not follow mass of the universe.

7571 (N—86-31483, pp vp) **Elementary particle physics.** Perkins, D.H. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Elementary particle physics is discussed. Status of the Standard Model of electroweak and strong interactions; phenomena beyond the Standard Model; new accelerator projects; and possible contributions from non-accelerator experiments are examined.

7572 (N—86-31483, pp vp) **Cosmogenic nuclei.** Raisbeck, G.M. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Cosmogenic nuclei, nuclides formed by nuclear interactions of galactic and solar cosmic rays with extraterrestrial or terrestrial matter, are discussed. Long lived radioactive cosmogenic isotopes are focused upon. Their uses in dating, as tracers of the interactions of cosmic rays with matter, and in obtaining information on the variation of primary cosmic ray flux in the past are discussed.

7573 (N—86-31483, pp vp) **Extragalactic astronomy.** Burbidge, E.M. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Components of the active extragalactic universe are examined to discover what extragalactic objects exhibit physical processes of the same kind as those thought to be important within the galaxy. Radio galaxies; quasars; bulk ejection from galactic objects such as novae supernovae, and other galactic nuclei; the red shifts of quasars; and the possibility of non-cosmological red shifts are among the topics discussed. It is concluded that the highest energy cosmic rays may have an extragalactic or extragalactic origin.

7574 (N—86-31483, pp vp) **Gamma ray astronomy from satellites and balloons.** Schoenfelder, V. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

A survey is given of gamma ray astronomy topics presented at the Cosmic Ray Conference. The major conclusions at the Cosmic Ray Conference in the field of gamma ray astronomy are given. (1) MeV-emission of gamma-ray bursts is a common feature. Variations in duration and energy spectra from burst to burst may explain the discrepancy between the measured log N - log S dependence and the observed isotropy of bursts. (2) The gamma-ray line at 1.809 MeV from Al(26) is the first detected line from a radioactive nucleosynthesis product. In order to understand its origin it will be necessary to measure its longitude distribution in the Milky Way. (3) The indications of a gamma-ray excess found from the direction of Loop I is consistent with the picture that the bulk of cosmic rays below 100 GeV is produced in galactic supernova remnants. (4) The interpretation of the large scale distribution of gamma rays in the Milky Way is controversial. At present an extragalactic origin of the cosmic ray nuclei in the GeV-range cannot be excluded from the gamma ray data. (5) The detection of MeV-emission from Cen A is a promising step towards the interesting field of extragalactic gamma ray astronomy.

7575 (N—86-31483, pp vp) **Cosmic gamma-rays and cosmic nuclei above 1 TeV.** Watson, A.A. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Work on cosmic gamma rays and cosmic nuclei above I TeV is described and evaluated. The prospect that gamma ray astronomy above I TeV will give new insights into high energy cosmic ray origin within our galaxy is particularly bright.

7576 (N—86-31483, pp vp) **Galactic cosmic ray composition.** Meyer, J.P. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

An assessment is given of the galactic cosmic ray source (GCRS) elemental composition and its correlation with first ionization potential. The isotopic composition of heavy nuclei; spallation cross sections; energy spectra of primary nuclei; electrons; positrons; local galactic reference abundances; comparison of solar energetic particles and solar coronal compositions; the hydrogen; lead; nitrogen; helium; and germanium deficiency problems; and the excess of elements are among the topics covered.

7577 (N—86-31483, pp vp) **Cosmic ray sources, acceleration and propagation.** Ptuskin, V.S. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

A review is given of selected papers on the theory of cosmic ray (CR) propagation and acceleration. The high isotropy and a comparatively large age of galactic CR are explained by the effective interaction of relativistic particles with random and regular electromagnetic fields in interstellar medium. The kinetic theory of CR propagation in the Galaxy is formulated similarly to the elaborate theory of CR propagation in heliosphere. The substantial difference between these theories is explained by the necessity to take into account in some cases the collective effects due to a rather high density of relativisitc particles. In particular, the kinetic CR stream instability and the hydrodynamic Parker instability is studied. The interaction of relativistic particles with an ensemble of given weak random magnetic fields is calculated by perturbation theory. The theory of CR transfer is considered to be basically completed for this case. The main problem consists in poor information about the structure of the regular and the random galactic magnetic fields. An account is given of CR transfer in a turbulent medium.

7578 (N—86-31483, pp vp) **Particle acceleration by the sun.** Lin, R.P. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

A review is given of the analysis of new observations of energetic particles and energetic secondary emissions obtained over the solar maxium (approx. 1980) by the Solar Maximum mission, Hinotori, the international Sun-Earth Explorer, Helios, Explorer satellites, and Voyager spacecraft. Solar energetic particle events observed in space, He(3)- rich events, solar gamma rays and neutrons, and solar neutrinos are discussed.

7579 (N—86-31483, pp vp) **Coronal and interplanetary propagation, interplanetary acceleration, cosmic-ray observations by deep space network and anomalous component.** Ng, C.K. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The purpose is to provide an overview of the contributions presented in sessions SH3, SH1.5, SH4.6 and SH4.7 of the 19th International Cosmic Ray Conference. These contributed papers indicate that steady progress continues to be made in both the observational and the theoretical aspects of the transport and acceleration of energetic charged particles in the heliosphere. Studies of solar and interplanetary particles have placed emphasis on particle directional distributions in relation to pitch-angle scattering and magnetic focusing, on the rigidity and spatial dependence of the mean free path, and on new propagation regimes in the inner and outer heliosphere. Coronal propagation appears in need of correlative multi-spacecraft studies in association with detailed observation of the flare process and coronal magnetic structures. Interplanetary acceleration has now gone into a consolidation phase, with theories being worked out in detail and checked against observation.

7580 (N—86-31483, pp vp) **Modulation and anisotropy of galactic cosmic rays in the heliosphere.** Kota, J. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Modulation models are discussed with more time spent on two current ideas: episodic modulation and drift models. The various types of anisotropies are addreased. Finally, other time variations and correlation studies are reviewed.

7581 (N—86-31483, pp vp) **Forbush decreases, geomagnetic and atmospheric effects and cosmogenic nuclides.** Flueckiger, E.O. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

An overview and synthesis is given of recent developments that have occurred in the areas of Forbush decreases, geomagnetic and atmospheric effects, and cosmogenic nuclides. Experimental evidence has been found for substantial differences in the effects of the various types of interplanetary perturbations on cosmic rays, and for a dependence of these effects on the three-dimensional configuration of the interplanetary medium. In order to fully understand and to be able to simulate the solar cosmic ray particle access to the polar regions of the earth we need accurate models of the magnetospheric magnetic field. These models must include all major magnetospheric current systems (in particular the field aligned currents), and they should represent magnetically quiet time periods as well as different levels of geomagnetic activity. In the evolution of magnetospheric magnetic field models, cosmic ray and magnetospheric physicists should work closely together since cosmic ray measurements are a powerful additional tool in the study of the perturbed magnetosphere. In the field of cosmogenic nuclides, finally, exciting new results and developments follow in rapid succession. Thanks to new techniques and new isotopes the analysis of cosmic ray history has entered into a new dimension.

7582 (N—86-31483, pp vp) **High energy interactions of cosmic ray particles.** Jones, L.W. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The highlights of seven sessions of the Conference dealing with high energy interactions of cosmic rays are discussed. High energy cross section measurements; particle production-models of experiments; nuclei and nuclear matter; nucleus-nucleus collision; searches for magnetic monopoles; and studies of nucleon decay are covered.

7583 (N—86-31483, pp vp) **Emulsion chamber observations and interpretation (HE 3).** Shibata, M. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Experimental results from Emulsion Chamber (EC) experiments at mountain altitudes or at higher levels using flying carriers are examined. The physical interest in this field is concentrated on the strong interaction at the very high energy region exceeding the accelerator energy, also on the primary cosmic ray intensity and its chemical composition. Those experiments which observed cosmic ray secondaries gave information on high energy interaction characteristics through the analyses of secondary spectra, gamma-hadron families and C-jets (direct observation of the particle production occuring at the carbon target). Problems of scaling violation in fragmentation region, interaction cross section, transverse momentum of produced secondaries, and some peculiar features of exotic events are discussed.

7584 (N—86-31483, pp vp) **Extensive air showers (HE-4).** Clay, R.W. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Ultra high energy (UHE) gamma ray astronomy is an exciting area which has added a new sense of purpose to ground based array work. There is much to be done before UHE gamma ray showers can be understood properly and it is important to remain conservative with claims while the properties of such showers are still not clear. The muon content is only one of the properties that needs to be clarified. It remains to be seen how well progress occurs on the second order problem of detailed interaction parameters once the gross features are clarified. The shower disk thickness has become an area of intense study with interest in Linsley's technique for measuremnts of giant showers and in the study of structure near the core for improving fast timing and studying delayed subshowers. Perhaps the most significant area of promise for the future is individual shower develpments with Cerenkov and, particularly, air fluorescence techniques. The importance and potential of having relatively complete information on a complete set of individual showers can hardly be overestimated. A complete understanding of the observation process is needed to determine whether or not the recorded data set is complete at a given energy, apparent core distance, and zenith angle.

7585 (N—86-31483, pp vp) **Muons and neutrinos.** Stanev, T. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The first generation of large and precise detectors, some initially dedicated to search for nucleon decay has accumulated significant statistics on neutrinos and high-energy muons. A second generation of even better and bigger detectors are already in operation or in advanced construction stage. The present set of experimental data on muon groups and neutrinos is qualitatively better than several years ago and the expectations for the following years are high. Composition studies with underground muon groups, neutrino detection, and expected extraterrestrial neutrino fluxes are discussed.

7586 (N—86-31483, pp vp) **Ground-based very high energy gamma ray astronomy: Observational highlights.** Turver, K.E. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

It is now more than 20 years since the first ground based gamma ray experiments involving atmospheric Cerenkov radiation were undertaken. The present highlights in observational ground-based very high energy (VHE) gamma ray astronomy and the optimism about an interesting future for the field follow progress in these areas: (1) the detection at increased levels of confidence of an enlarged number of sources so that at present claims were made for the detection, at the 4 to 5 sd level of significance, of 8 point sources; (2) the replication of the claimed detections with, for the first time, confirmation of the nature and detail of the emission; and (3) the extension of gamma ray astronomy to the ultra high energy (UHE) domain. The pattern, if any, to emerge from the list of sources claimed so far is that x-ray binary sources appear to be copious emitters of gamma rays over at least 4 decades of energy. These x-ray sources which behave as VHE and UHE gamma ray emitters are examined.

7587 (N—86-31483, pp vp) **Why is Cygnus X-3 (with related sources) a highlight of cosmic-ray astrophysics?.** Hillas, A.M. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Cygnus X-3 and some apparently related systems have sprung into remarkable prominence. The reasons for this great interest are summarized. Some recent developments in the picture of these sources are also outlined.

7588 (N—86-31483, pp vp) **Observational properties of cosmic gamma-ray bursts.** Mazets, E.P. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

A brief overview of the major observational results obtained in gamma-ray burst studies is presented. Also discussed is to what extent the thermonuclear model, which appears at present to be the most plausible, can account for the observed properties of the bursts. The investigation of gamma-ray bursts should cover observations of the time histories of events, energy spectra, and their variablility, source localization, and inspection of the localization regions during the active and quiescent phases of the source in other wavelengths, as well as, evaluation of the statistical distributions of the data obtained.

7589 (N—86-31483, pp vp) **Observations of shock acceleration processes in the solar wind.** Scholer, M. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Substantial evidence was accumulated over more than two decades that ion acceleration occurs at all collisionless shocks sampled directly in the solar system. The various shock waves in the heliosphere and the associated energetic particle phenomena are shown schematically. Three shocks have attracted considerable attention in recent years: corotating shocks due to the interaction of fast and slow solar wind streams during solar minimum, travelling interplanetary shocks due to coronal mass ejections, and planetary bow shocks. The signatures of these shocks and of their energetic particles are briefly reviewed. The most prominent theoretical models for shock acceleration are also reviewed. Recent observations at the earth's bow shock and at quasi-parallel interplanetary shocks are discussed in detail.

7590 (N—86-31483, pp vp) **Signal from Cyg X-3, as recorded in some underground experiments, real?.** Chudakov, A.E. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Most of the excitement concerning the underground detection of signals from Cyg X-3 comes not from astrophysical grounds, but from the contradiction with surface experimental data. Believing in the Cyg X-3 signal underground and also that the main processes of muon production are well knownm the conclusion was drawn that the signal in EAS Cherenkov or counter experiments could be remarkably high, which is not the case. Possible solutions to this discrepancy are discussed.

7591 (N—86-31483, pp vp) **Evidence from the Soudan 1 experiment for underground muons associated with Cygnus X-3.** Ayres, D.S.E. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The Soudan 1 experiment has yielded evidence for an average underground muon flux of approximately 7 x 10 to the minus 11th power/sq cm/s, which points back to the x-ray binary Cygnus X-3, and which exhibits the 4.8 h periodicity observed for other radiation from this source. Underground muon events which seem to be associated with Cygnus X-3 also show evidence for longer time variability of the flux. Such underground muons cannot be explained by any conventional models of the propagation and interaction of cosmic rays.

7592 (N—86-31483, pp vp) **Observation of muons from Cygnus X-3 in the NUSEX experiment.** Piazzoli, B.D. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Ground based observations by means of Cerenkov light detectors and air shower arrays have established that Cyngus X-3 is a powerful source of high energy particles. The detection of a 10 to the 15th power eV signal was first reported by the Kiel experiment. Air showers with large age parameter were accepted in order to select those generated by primary gamma rays. At variance with the expectation, the muon density associated with these events was found to be surprisingly high. This puzzling result stimulated a temporal analysis of the muons recorded in Nucleon Stability Experiment (NUSEX) coming from the region around the source. A positive signal was found suggesting the presentation of this result. The analysis of the data recorded during the 2.4 years of effective working time is presented with a fine tuning of the period and the energy spectrum of the muons from the Cygnus X-3 direction derived assuming consistency between NUSEX and SOUDAN results.

7593 (N—86-31483, pp vp) **Search for a periodic signal from Cygnus X-3 usingmuons observed underground in the Frejus detector (4800 mwe).** Bareyre, P.; Barloutaud, R.; Becker, K.H.; Behr, L.; Berger, C.; Bland, R.W.; Chardin, G.; Daum, H.J.; Degrange, B.; Demski, S. (Gesamthochschule, Wuppertal, West Germany; Ecole Polytechnique, Palaiseau, France; Technische Hochschule, Aachen, West Germany). Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Periodic signals from Cygnus X-3 in the ultra high energy range were recently reported by air shower arrays and attributed to gamma rays. Although gamma rays are expected to produce muon-poor showers, the preceding observations have stimulated similar studies based on underground muons. Two groups have claimed a significant underground signal coming from Cygnus X-3. The results are, however, extremely difficult to explain in the present framework of particle physics, and clearly need confirmation. The preliminary results obtained from the Frejus underground detector during its first 16 months of operation (March 1984 to June 1985) are presented.

7594 (N—86-31483, pp vp) **Cosmic ray spectrum above 10(19) EV at Volcano Ranch and Haverah Park.** Linsley, J. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The cosmic ray energy per particle spectrum above 10 to the 19th power eV is measured the same way that energy spectra are measured at much lower energies, by counting all of the particles in a specified energy range that are incident per unit time with trajectories within specified geometrical limits. Difficulties with background or poorly known detection efficiency are markedly less than in some other cosmic ray measurements. The fraction of primary energy given to muons, neutrinos, and slow hadrons is less than 10% in this region, so the primary energy equals the track length integral of the secondary electrons with only a small correction for the energy given to other kinds of particles. Results from Volcano Ranch and Haverah Park are compared with results from the Yakutsk experiment.

7595 (N—86-31483, pp vp) **Measuring the energy spectrum of primary cosmic rays with the Yakutsk EAS array.** Khristiansen, G.B. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The Yakutsk Extensive Air Showers (EAS) array was designed for detecting the showers generated by the 10 to the 17th power to 10 to the 20th power eV primary cosmic rays and consists of numerous electron, muon, and Cerenkov light detectors arranged on a 20 sq km area terrain. The array is featured by the feasibility to detect the EAS-produced Cerenkov light, hence, as will be shown, to find the mean energy of the primary particles generating an ensemble of EAS of given size. Date collected is discussed.

7596 (N—86-31483, pp vp) **Cosmic ray spectrum above 10(17) eV.** Winn, M.M.; Ulrichs, J.; Horton, L.; Mccusker, C.B.A.; Peak, L.S. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The final analysis of the data obtained by the Sydney University Giant Airshower Recorder (SUGAR) is presented. The data has been reanalysed to take into account the effects of afterpulsing in the photomultiplier tubes. Event data was used to produce a spectrum of equivalent vertical muon number and from this a model dependent primary energy spectrum was obtained. These spectra show good evidence for the Ankle: a flattening at 10(19) eV. There is no sign of the cut-off which would be expected from the effects of the universal black body radiation.

7597 (N—86-31483, pp vp) **High energy nucleus-nucleus collisions.** Wosiek, B. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Experimental results on high energy nucleus-nucleus interactions are presented. The data are discussed within the framework of standard super-position models and from the point-of-view of the possible formation of new states of matter in heavy ion collisions.

7598 (N—86-31483, pp vp) **Studies of air showers produced by primaries 10(16) eV using a combined scintillation and water-Cerenkov array.** Brooke, G.; Perrett, J.C.; Watson, A.A. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

An array of 8 x 1.0 sq m plastic scintillation counters and 13 water-Cerenkov detectors (1 to 13.5 sq m) were operated at the center of the Haverah Park array to study some features of air showers produced by 10(16) eV primaries. Measurements of the scintillator lateral distribution function, the water-Cerenkov lateral distribution function, and of the distance dependence of the Cerenkov/scintillator ratio are described.

7599 (N—86-31483, pp vp) **Homestake surface-underground scintillators: Initial results.** Cherry, M.L.; Corbato, S.; Daily, T.; Fenyves, E.J.; Kieda, D.; Lande, K.; Lee, C.K. (Texas Univ., Dallas). Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The first 70 tons of the 140-ton Large Area Scintillation Detector (LASD) have been operating since Jan. 1985 at a depth of 4850 ft. (4200 m.w.e.) in the Homestake Gold Mine, Lead, S.D. A total of 4 x 10(4) high-energy muons (E sub mu is approx. 2.7 TeV at the surface) have been detected. The remainder of the detector is scheduled to be in operation by the Fall of 1985. In addition, a surface air shower array is under construction. The first 27 surface counters, spaced out over an area of 270' x 500', began running in June, 1985. The LASD performance, the potential of the combined shower array and underground muon experiment for detecting point sources, and the initial results of a search for periodic emission from Cygnus X-3 are discussed.

7600 (N—86-31483, pp vp) **Lead, platinum and other heavy elements in the primary cosmic radiation: HEAO-3 results.** Waddington, C.J.; Binns, W.R.; Brewster, N.R.; Fixsen, D.J.; Garrard, T.L.; Israel, M.H.; Klarmann, J.; Newport, B.J.; Stone, E.C. (Washington Univ., St. Louis, MO; California Institute of Technology, Pasadena). Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

An observation of the abundances of cosmic-ray lead and platinum-group nuclei using data from the HEAO-3 Heavy Nuclei Experiment (HNE), which consisted of ion chambers mounted on both sides of a plastic Cherenkov counter (Binns et al., 1981) is reported. Further analysis with more stringent selections, inclusion of additional data, and a calibration at the LBL Bevalac, have allowed the determination of the abundance ratio of lead and the platinum group of elements for particles that had a cutoff rigidity R(c) 5 GV. The observed ratio for Pb/Pt is distinctly lower than that predicted by any of the standard models for cosmic ray sources. It is possible that the difference is not an indication that the cosmic ray source composition is greatly different from that of the solar system, but rather that there is less Pb in the solar system and in the r-process than is assumed in the standard models.

7601 (N—86-31483, pp vp) **Automated scanning of plastic nuclear track detectors using the Minnesota star scanner.** Fink, P.J.; Waddington, C.J. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The problems found in an attempt to adapt an automated scanner of astronomical plates, the Minnesota Automated Dua' Plate Scanner (APS), to locating and measuring the etch pits produced by ionizing particles in plastic nuclear track detectors (CR-39) are described. A visual study of these pits was made to determine the errors introduced in determining positions and shapes. Measurements made under a low power microscope were compared with those from the APS.

7602 (N—86-31483, pp vp) **Cosmic ray anisotropies at high energies.** Martinic, N.J.; Alarcon, A.; Teran, F. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The directional anisotropies of the energetic cosmic ray gas due to the relative motion between the observers frame and the one where the relativistic gas can be assumed isotropic is analyzed. The radiation fluxes formula in the former frame must follow as the Lorentz invariance of dp/E, where p, E are the 4-vector momentum-energy components; dp is the 3-volume element in the momentum space. The anisotropic flux shows in such a case an amplitude, in a rotating earth, smaller than the experimental measurements from say, EAS-arrays for primary particle energies larger than 1.E(14) eV. Further, it is shown that two consecutive Lorentz transformations among three inertial frames exhibit the violation of dp/E invariance between the first and the third systems of reference, due to the Wigner rotation. A discussion of this result in the context of the experimental anisotropic fluxes and its current interpretation is given.

7603 (N—86-31483, pp vp) **High energy electrons beyond 100 GEV observed by emulsion chamber.** Nishimura, J.; Fujii, M.; Yoshida, A.; Taira, T.; Aizu, H.; Nomura, Y.; Kobayashi, T.; Kazuno, M.; Nishio, A.; Golden, R.L. (Kanagawa Univ., Japan; Kanagawa Prefectual College, Japan; Aoyamagakuin Univ., Tokyo, Japan; Toho Univ., Tokyo, Japan; Kyoto Univ., Kumatori, Japan). Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Much efforts have been expended to observe the spectrum of electrons in the high energy region with large area emulsion chambers exposed at balloon altitudes, and now 15 electrons beyond 1 TeV have been observed. The observed integral flux at 1 TeV is (3.24 + or - 0.87)x10(-5)/sq m sec sr. The statistics of the data around a few hundred GeV are also improving by using new shower detecting films of high sensitivity. The astrophysical significance of the observed spectrum are discussed for the propagation of electrons based on the leaky box and the nested leaky box model.

7604 (N—86-31483, pp vp) **Diffusive electron acceleration at SNR shock fronts and the observed SNR radio spectral indices.** Bogdan, T.J.; Lee, M.A.; Lerche, I.; Webb, G.M. (New Hampshire Univ., Durham; South Carolina Univ., Columbia; Arizona Univ., Tucson). Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

The radio synchrotron emission from relativistic electrons in shell supernova remnants (SNRs) provides a unique opportunity to probe the energy distribution of energetic electrons at their acceleration site (SNR shock fronts). This information provides insight into the acceleration mechanism(s). The implications of these observations for the diffusive (first-order Fermi) acceleration of electrons at the SNR shock fronts are discussed.

7605 (N—86-31483, pp vp) **Elemental abundances in corotating events.** Vonrosenvinge, T.T.; Mcguire, R.E. Feb 1986. NTIS, PC A$200.00/MF $200.00. (NASA-CP—2376-VOL-9; NAS—1.55:2376-VOL-9; CONF-850883—Vol.9).

From 19. international cosmic ray conference; La Jolla, CA, USA (11 Aug 1985).

Large, persistent solar-wind streams in 1973 and 1974 produced corotating interaction regions which accelerated particles to energies of a few MeV/nucleon. The proton to helium ratio (H/He) reported was remarkably constant at a value (22 + or - 5) equal to that in the solar wind (32 + or - 3), suggesting that particles were being accelerated directly out of the solar wind. Preliminary results from a similar study approximately 11 years (i.e., one solar cycle) later are reported. Corotating events were identified by surveying the solar wind data, energetic particle time-histories and anisotropies. This data was all obtained from the ISEE-3/ICE spacecraft. These events also show H/He ratios similar to that in the solar wind. In addition, other corotating events were examined at times when solar flare events could have injected particles into

the corresponding corotating interaction regions. It was found that in these cases there is evidence for H/He ratios which are significantly different from that of the solar wind but which are consistent with the range of values found in solar flare events.

7606 **(N—86-31522) Gradients and anisotropies of high energy cosmic rays in the outer heliosphere.** Fillius, W.; Roelof, E.C.; Smith, E.J.; Wood, D.; Ip, W.H. (California Univ., San Diego, La Jolla (USA)). 1985. 4p. (NASA-CR—176944; NAS—1.26:176944). NTIS, PC A02/MF A01.

Two cosmic rays which pass through the same point going in opposite directions will, in the absence of scattering and inhomogeneities in the magnetic field, trace helices about adjacent flux tubes, whose centerlines are separated by one gyrodiameter. A directional anisotropy at the point suggests a difference in the number of cosmic rays loading the two flux tubes; that is, a density gradient over the baseline of a gyrodiameter. Previous studies at lower energies have shown that the cosmic ray density gradients vary in time and space. It is suggested that the radial gradient associated with solar cycle modulation is supported largely by narrow barriers which encircle the sun and propagate outward with the solar wind. If so, the anisotropy is a desirable way to detect spatial gradients, because it can be associated with the local solar wind and magnetic field conditions. Anisotropic measurements made by Cerenkov detectors on Pioneers 10 and 11 were studied. It was found that local anisotropy varies greatly, but that the long term average is consistent with the global radial gradient measured between two spacecraft over a baseline of many AU.

7607 **Constraints on particle physics from cosmology.** Schramm, D.N.; Charlton, J.C. (Enrico Fermi Institute, Univ. of Chicago, Chicago, IL). pp 431-446 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

Cosmology and particle physics have become symbiotic in their relationship. In the past, developments in physics have been used to explain astrophysics problems. Recently, cosmology also has been able to place constraints on particle properties and these constraints can be tested by experiment. Thus, the flow of information at the interface of particle physics and cosmology is no longer just one-way. (Astronomy is no longer a parasite of physics.) Many examples of the interchange are described in this review. The timeline of cosmology is rapidly filling in as later events find their explanations in earlier events. In this review, the authors mention what is known about each epoch and show how it might constrain the particle models. Since a great deal of effort is devoted currently to the study of the dark matter problem, special emphasis will be placed on this issue. This study of dark matter and galaxy formation will allow us to draw upon much of what was discussed in earlier epochs. This review draws heavily on a previous review by the authors.

7608 **(N—86-30615) Volatile components and continental material of planets.** Florenskiy, K.P.; Nikolayeva, O.V. Translated from *Geokhimiya ;* No. 9, 1251-1267(1984). 33p. (NASA-TM—88478; NAS—1.15:88478). NTIS, PC A03/MF A01.

It is shown that the continental material of the terrestrial planets varies in composition from planet to planet according to the abundances and composition of true volatiles ($H_20$, $CO_2$, etc.) in the outer shells of the planets. The formation of these shells occurs very early in a planet's evolution when the role of endogenous processes is indistinct and continental materials are subject to melting and vaporizing in the absence of an atmosphere. As a result, the chemical properties of continental materials are related not only to fractionation processes but also to meltability and volatility. For planets retaining a certain quantity of true volatile components, the chemical transformation of continental material is characterized by a close interaction between impact melting vaporization and endogeneous geological processes.

## 6402 Atmospheric Physics

*REFER ALSO TO CITATION(S) 7245, 7245, 7246*

7609 **(AD-A—171562/2/XAB) Empirical relationship between Kp and the tail-lobe magnetic field.** Rothwell, P.L. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 1 Aug 1986. 7p. (AFGL-TR—86-0177). NTIS, PC A02/MF A01.

Published in J. of Geophysical Research, Vol. 91, No. A8, 9012-9016, 1 Aug 1986.

This paper establishes a useful empirical relationship between the readily available magnetic activity index, Kp, and the tail-lobe magnetic field strength. A simple (dipole plus tail field plus ring current) magnetic field model is combined with results that relate the location of the equatorward boundary of auroral oval with Kp. The results are tested by taking over 500 samples of Kp and converting them to the corresponding lobe field-strength values which are then plotted as a frequency distribution. This distribution is compared with a similar distribution of over 700 hours of IMP 4 tail-lobe magnetic field measurements taken during the same time period. The agreement between the two distributions is excellent only when a model ring current is included. This implies that the ring current makes a significant contribution to the location of the equatorward boundary of the auroral oval, particularly during periods of high Kp. Comparisons are made between the present model and the zero energy Alfven-layer calculations that have appeared in the literature.

7610 **(AD-A—171869/1/XAB) Solar-proton event of 16 February 1984: observations at low altitude over the earth's polar caps. Technical report.** Blake, J.B.; Kolasinski, W.A. (Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.). 1 Aug 1986. 20p. (TR—0086(6940-05)-8). NTIS, PC A02/MF A01.

This report briefly describes the solar proton intensities as a function of time over the Earth's Polar Caps as observed in the veto counters of the Space Sciences Laboratory x-ray image during the event of 16 February 1984. This event is particularly interesting because the large anisotropy of the proton fluxes in the interplanetary medium caused substantial intensity variations in the fluxes at low altitudes over the polar caps.

7611 **(AD-A—171937/4/XAB) Effects of different convection models upon the high-latitude ionosphere.** Rasmussen, C.E.; Schunk, R.W.; Sojka, J.J. (Utah State Univ., Logan (USA). Center for Atmospheric and Space Sciences). 1986. 19p. NTIS, PC A02/MF A01.

It is well known that convection electric fields have an important effect on the ionosphere at high latitudes and that a quantitative understanding of their effect requires a knowledge of plasma convection over the entire high latitude region. Two empirical models of plasma convection that have been proposed for use in studying the ionosphere are the Volland and Heelis models. Both of these models provide a similar description of two-celled ionospheric convection, but they differ in several ways, in particular, in the manner in which plasma flows over the central polar-cap and near the polar cap boundary. To obtain a better understanding of the way in which these two models affect the ionosphere, two separate runs of the high-latitude, time-dependent ionospheric model were made, with only the convection models distinguishing the two runs. It was found that the two models lead to differences in the ionosphere but often the differences are subtle and are swamped by universal time effects. The most notable differences are in predictions of the height of the F2 peak and in the ion temperature, particularly along the evening polar-cap boundary and in the cusp region. For these two parameters, the differences caused by the two different convection models dominate the universal time effects. One question that arises is whether one could examine measurements of plasma density and temperature and determine which of the two convection models most accurately represents actual ionospheric convection.

7612 (AD-A—171998/8/XAB) **Dynamical-chemical coupling in the mesosphere and lower thermosphere. Final report, 1 June-1 December 1984.** Forbes, J.M. (Boston Univ., MA (USA). Dept. of Electrical Computer and Systems Engineering). 31 Jan 1985. 4p. NTIS, PC A02/MF A01.

The dynamic ionosphere over Arecibo is simulated using a finite element technique. It is shown that the so-called collapse of the Arecibo F-layer is caused by the upward-propagating semidiurnal tide excited in the upper stratosphere by ozone heating. The steep underside density gradients observed in conjunction with the collapse are shown to be due to the shear in the meridional wind field of the semidiurnal tide. These gradients are capable of triggering the gradient drift plasma instability, and accounting for plasma irregularity formation and observations of VHF scintillations associated with the collapse phenomenon.

7613 (MAP-HANDBK—8, pp vp) **Two classes of medium-scale traveling ionospheric disturbances observed with an array on HF-Doppler sounders.** Shibata, T.; Okuzawa, T. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

The importance of the quasi-evanescent mode of acoustic-gravity waves (AGW) was recently stressed to elaborate on the daytime dispersion characteristics of horizontal velocity of medium-scale traveling ionospheric disturbances (MS-TID) which were observed by a high frequency Doppler (HFD) sounder array in central Japan. Observed MS-TIDs were classified into two categories: the internal mode and the quasi-evanescent mode as regards physical implication. Nonlinear wave-wave interaction is proposed in an attempt to explain salient features of the latter-class TID.

7614 (MAP-HANDBK—8, pp vp) **Wave motions in the upper atmospheric sodium layer observed with a lidar technique.** Kamiyama, H.; Tomita, F. (Ministry of Posts and Telecommunications, Tokyo, Japan). Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Since the middle of 1980, the vertical profile of the atmospheric sodium layer was observed with a tunable laser radar at Mt. Zao Observatory in northern Japan. The principal characteristics of the lidar system are summarized. The output wavelength is continuously monitored by using a sodium resonance cell, a spectrometer, and a Fabry-Perot interferometer provided with the reference spectrum of the sodium lamp. Owing to the strict temperature control of the filters, the tuning is sufficiently stable throughout the night. The calibration of the absolute sodium density was carried out by adopting the method established by previous works.

7615 (MAP-HANDBK—8, pp vp) **Acoustic gravity wave induced by a point source in the middle atmosphere.** Zhang, X.J.; Xiong, N.L. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Acoustic gravity wave (AGW) results computed for a stationary impulsive point source and a moving point source in the middle atmosphere are presented. For a stationary impulsive point Row's far field formula of the AGW was extended into the near field one, which comprises the Zeroth order Bessel function and its derivative terms. When (t-t sub o) is not large, the contribution of the derivative terms is important. The computed results agree with the experimental ones. For a moving point source with supersonic velocity, AGW is calculated using the moving point theory. Two solar eclipses that occurred in the lower latitude and over the ocean on Feb. 16, 1980, and June 11, 1983, were compared. The results show that the theoretical curve of AGW is fairly consistent with the observed ones.

7616 (MAP-HANDBK—8, pp vp) **Estimation of neutral wind velocity in the ionospheric heights by HF-Doppler technique.** Kitamura, T.; Takefu, M.; Hiroshige, N. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

Three net stations located about 100 kilometers apart were set up around the station of the standard frequency and time signals (JJY) in central Japan and measurements of atmospheric gravity waves in the ionospheric heights (F-region, 200 to 400 km) were made by means of the HF-Doppler technique during the period of February 1983 to December 1983. The frequencies of the signals received are 5.0, 8.0 and 10.0 MHz, but only the 8.0 MHz signals are used for the present study, because no ambiguities due to the interference among other stations such as BPM, BSF, etc. exist by the use of 8.0 MHz. Two main results concerning the horizontal phase velocity of the atmospheric gravity waves with periods of 40 to 70 min may be summarized as follows: (1) the value of the phase velocity ranges from 50 m/s to 300 m/s; (2) the direction of the gravity wave propagation shows a definite seasonal variation. The prevailing direction of the gravity waves in winter is from north to south, which is consistent with the results obtained from other investigations. On the other hand, the two directions, from northeast to southwest and from southeast to northeast, dominate in summer.

7617 (MAP-HANDBK—8, pp vp) **Local time distribution of the SSC-associated HF-Doppler frequency shifts.** Kikuchi, T.; Sugiuchi, H.; Ishimine, T. Dec 1985. NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801.

From MAP Symposium; Kyoto, Japan (26 Nov 1984).

The HF-Doppler frequency shift observed at the storm's sudden commencement is composed of a frequency increase (+) and decrease (-), and classified into four types, SCF(+ -), SCF(- +), SCF(+) and SCF(-). Since the latter two types are special cases of the former two types, two different kinds of electrical field exist in the F region and cause the ExB drift motion of plasma. HUANG (1976) interpreted the frequency increase of SCF(+ -) as due to the westward induction electric field proportional to delta H/ delta t and the succeeding frequency decrease due to the eastward conduction electric field which produces ionospheric currents responsible for the magnetic increase on the ground. In spite of his success in interpreting the SCF(+ -), some other interpretations are needed for the explanation of the whole set of SCF's, particularly SCF(- +). Local time distributions of the SCF's are derived from 41 SCF's which are observed on the HF standard signal (JJY) as received in Okinawa (path length =1600 km) and Kokubunji (60 km). It is shown that the SCF(+ -) appears mainly during the day, whereas the SCF(- +) is observed during the night. The results indicate that the preliminary frequency shift (+) of SCF(+ -) and (-) of SCF(- +) is caused by a westward electric field in the dayside hemisphere, while by an eastward electric field in the nightside hemisphere. The main frequency shift (-) of SCF(+ -) and (+) of SCF(- +) is caused by the reversed electric field. Consequently, the preliminary frequency shift is caused by the dusk-to-dawn electric field, while the main frequency shift by the dawn-to-dusk electric field.

7618 (N—86-29301) **Thermosphere Dynamics Workshop, volume 2.** Mayr, H.G.; Miller, N.J. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Jun 1986. 461p. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2). NTIS, PC A20/MF A01.

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

Atmospheric observations reported on include recent measurements of thermospherical composition, gas temperatures, auroral emissions, ion-neutral collisional coupling, electric fields, and plasma convection. Theoretical studies reported on include model calculations of thermospherical general circulation, thermospheric tides, thermospheric tidal coupling to the lower atmosphere, interactions between thermospheic chemistry and dynamics and thermosphere-ionosphere coupling processes. The abstracts provide details given in each talk but the figures represent the fundamental information exchanged within the workshop

7619 (N—86-29301, pp vp) **Observations of vertical winds and the origin of thermospheric gravity waves launched by auroral substorms and westward travelling surges.** Rees, D. Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

Several sequences of observations of strong vertical winds in the upper thermosphere are discussed, in conjunction with models of the generation of such winds. In the auroral oval, the strongest upward winds are observed in or close to regions of intense auroral precipitation and strong ionospheric currents. The strongest winds, of the order of 100 to 200 m/sec are usually upward, and are both localized and of relatively short duration (10 to 20 min). In regions adjacent to those displaying strong upward winds, and following periods of upward winds, downward winds of rather lower magnitude (40 to about 80 m/sec) may be observed. Strong and rapid changes of horizontal winds are correlated with these rapid vertical wind variations. Considered from a large scale viewpoint, this class of strongly time dependent winds propagate globally, and may be considered to be gravity waves launched from an auroral source. During periods of very disturbed geomagnetic activity, there may be regions within and close to the auroral oval where systematic vertical winds of the order of 50 m/sec will occur for periods of several hours. Such persistent winds are part of a very strong large scale horizontal wind circulation set up in the polar regions during a major geomagnetic disturbance. This second class of strong horizontal and vertical winds corresponds more to a standing wave than to a gravity wave, and it is not as effective as the first class in generating large scale propagating gravity waves and correlated horizontal and vertical oscillations. A third class of significant (10 to 30 m/sec) vertical winds can be associated with systematic features of the average geomagnetic energy and momentum input to the polar thermosphere, and appear in statistical studies of the average vertical wind as a function of Universal Time at a given location.

7620 (N—86-29301, pp vp) **Time-dependent dynamical response of the thermosphere to major geomagnetic disturbances.** Rees, D. Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

Several recent observations of thermospheric dynamics, made in the polar regions during extremely disturbed geomagnetic periods are reviewed. In general, the magnitude and the variability of winds in the thermospheric polar regions increases with magnetic activity, as measured by any of the conventional indices. However, none of the conventional indices is a particularly good aid to predicting wind magnitudes. In very general terms, two major factors may be considered in describing the wind system. The magnitude of the Interplanetary Magnetic Field (IMF) and, in particular, its southward component, determine the size of the auroral oval, and the strength of the cross-polar cap potential. This determines the size of the auroral oval, the magnitude of the sunward winds in the auroral oval and of those blowing anti-sunward over the polar cap, and is probably the major factor in determining the rate of geomagnetic energy deposition in the thermosphere. Superimposed on this enhanced polar circulation system are the effects of discrete auroral substorms. From a global view point, the effect of substorms is to generate a series of strong disturbances which propagate from their source region, usually near magnetic midnight in the auroral oval. The energy associated with discrete substorms is, however, usually a rather small proportion of the total global geomagnetic input during disturbed periods. These observations of thermospheric wind disturbances will be evaluated by comparison with global simulations of the thermospheric response to theoretical and semi-empirical models of the polar electric field, and of the effects of magnetospheric particle precipitation.

7621 (N—86-29301, pp vp) **Self-consistent modelling of the polar thermosphere and ionosphere to magnetospheric convection and precipitation (invited review).** Rees, D.; Fuller-Rowell, T.; Quegan, S.; Moffett, R. (Marconi Space and Defence Systems Ltd., Chelmsford England; Sheffield Univ., England). Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

It has recently been demonstrated that the dramatic effects of plasma precipitation and convection on the composition and dynamics of the polar thermosphere and ionosphere include a number of strong interactive, or feedback, processes. To aid the evaluation of these feedback processes, a joint three dimensional time dependent global model of the Earth's thermosphere and ionosphere was developed in a collaboration between University College London and Sheffield University. This model includes self consistent coupling between the thermosphere and the ionosphere in the polar regions. Some of the major features in the polar ionosphere, which the initial simulations indicate are due to the strong coupling of ions and neutrals in the presence of strong electric fields and energetic electron precipitation are reviewed. The model is also able to simulate seasonal and Universal time variations in the polar thermosphere and ionospheric regions which are due to the variations of solar photoionization in specific geomagnetic regions such as the cusp and polar cap.

7622 (N—86-29301, pp vp) **Particle precipitaion into the thermosphere (invited review).** Reiff, P.H. Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

A review of research on particle precipitation into the thermosphere is presented. Particle precipitation plays an important role in thermospheric dynamics, often being both the most important ionization source and the most important heat source, comparable to Joule heating rates in the auroral zones and typically exceeding solar ultraviolet as an ionization mechanism in the nightside auroral zones and winter polar caps. Rees (1963) has shown that, roughly speaking, one electron-ion pair is produced by each 35 eV of incident electron energy flux; thus, over half of the incident electron energy flux goes into heating rather than into ionization. Precipitating ions also can produce ionization, also requiring roughly 35 eV per pair; however, since ion energy fluxes are typically much weaker than electron fluxes, they have often been neglected. The particle precipitation into the thermosphere is both an important ionization source and an important heat source; since the globally integrated value can vary over more than a factor of ten, and the instantaneous local rate can vary over nearly three orders of magnitude global, maps of precipitation rates are extremely important for predicting thermospheric weather.

7623 (N—86-29301, pp vp) **Quadrupole ionosphere.** Rishbeth, H. Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

The principal features that might exist in the terrestrial paleoionosphere, if the geomagnetic field were to assume a quadrupole form during a polarity reversal are discussed. Complicated phenomena would be expected to occur at magnetic equators and magnetospherically-driven plasma convection might occur at latitudes where the magnetic field is steeply inclined. The influence of magnetic field strength on ionospheric structure is considered in general terms.

7624 (N—86-29301, pp vp) **EISCAT velocity patterns for theoretical plasma convection models.** Rishbeth, H.; Sojka, J.J. (Utah State Univ., Logan). Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

Theoretical line-of-sight velocities, as would be observed by the EISCAT radar, are computed for idealized models of plasma convection in the polar ionosphere. The calculations give the velocity as a function of range and Universal Time. For several variants of the Volland and Heelis convection models, how the maxima, minima and reversals of velocity depend on beam azimuth is examined. The analysis is designed to be applied to data from the UK-POLAR experiment, an example of which is shown.

7625 (N—86-29301, pp vp) **Joule heating and field-aligned currents: preliminary results from DE-2.** Sugiura, M. Jun 1986. NTIS, PC A20/MF A01. (NASA-CP—2389; REPT—85B0268; NAS—1.55:2389; CONF-8410456—Vol.2).

From Thermosphere dynamics workshop; Beltsville, MD, USA (3 Oct 1984).

There are three main processes by which energy is transferred from the magnetosphere to the thermosphere: (1) charge exchange of the ring current particles; (2) precipitation of charged particles; and (3) joule dissipation by the magnetosphere-ionosphere current systems. The importance of this last process has been recognized and the rate of joule heating has been estimated by many workers. Observations of the electric (E) and magnetic (B) fields from Dynamics Explorer Satellite 2 are providing a new set of data on field-aligned currents. One of the remarkable features found in these observations is the high correlation between an orthogonal pair of the E and B field components. In recent years, observational data have accrued concerning the relationship between the interplanetary magnetic field and the size of the polar cap and also about the evolution of a substorm or a magnetic storm. It is suggested that these findings be incorporated in future model calculations.

7626 (N—86-30272) **Thermal ion heating in the vicinity of the plasmapause: a Dynamics Explorer guest investigation. Final report, October 1984-March 1985.** Comfort, R.H. (Alabama Univ., Huntsville (USA)). Mar 1986. 13p. (NASA-CR—176993; NAS—1.26:176993). NTIS, PC A02/MF A01.

The ion thermal structure of the plasmasphere was investigated in a series of experiments. It appears that energy may be generally available to ion and electrons in the vinicity of the plasmapause from Coulomb interactions between ambient thermal plasma and low energy ring current and suprathermal ions, particularly O+. The amount of energy transferred depends on the densities and energies of each of the components. The spatial distribution of heating in turn depends critically on the spatial distribution of the different populations, especially on the density gradients. The spatial distribution of the thermal plasma is found to vary significantly on a diurnal time scale and is complicated by the plasmasphere erosion and refilling processes associated with magnetic activity and its aftermath. Thermal ion composition also appears to be influenced by the heating taking place, often increasing the heavy ion population in the vicinity of the plasmapause. The observations of equatorial heating near the plasmapause in the presence of equatorial noise also raise the likelihood of a wave source of energy. It is not unreasonable to expect that both particle and wave heat sources are significant, although not necessarily at the same times and places.

7627 **Field-aligned plasma flow in MHD simulations of magnetotail reconnection and the formation of boundary layers.** Birn, J.; Hones, E.W. Jr.; Schindler, K. (Los Alamos National Laboratory, University of California, Los Alamos, New Mexico). *Journal of Geophysical Research;* **91**: No. A10, 11116-11122(1 Oct 1986).

We have used our two-dimensional resistive MHD code to study details of the plasma flow in two classes of magnetotail reconnection models: (1) near-earth reconnection as initiated by the sudden occurrence of anomalous dissipation, which leads to plasmoid formation and ejection consistent with phenomenological magnetospheric substorm models, and (2) distant reconnection which is forced to occur near a given location by a nonuniform inflow of plasma, energy, and magnetic flux through the high-latitude boundaries modeling the possible effects of plasma entry through the plasma mantle, which expands until it reaches the plasma sheet. Near-earth reconnection produces predominantly tailward flow, which occupies a major part of the plasma sheet cross section in z. Except for narrow regions close to the neutral sheet, this flow is largely field aligned. Due to the fact that the onset of this fast flow closely coincides with plasma sheet thinning, the observation at a fixed satellite location off the central neutral sheet looks like the crossing of a flow boundary layer when the satellite exits from the plasma sheet into the lobe. The distant reconnection process showed several features consistent with observations in the near and distant tail: the formation of a distant neutral sheet, rather than a single neutral line with the possibility of the occurrence of multiple neutral lines and quasi-stagnant magnetic islands, and the splitting of the earthward flow into two boundary layers, or "separatrix layers," inside the magnetic separatrix that limits the region of closed magnetic flux tubes.

## 6403 Atomic, Molecular, And Chemical Physics

*REFER ALSO TO CITATION(S) 6939, 7219*

7628 **(AD-A—171559/8/XAB) Forces on neutral atoms due to electromagnetic fields. Annual summary report, 1 September 1985-31 August 1986.** Pritchard, D.E. (Massachusetts Inst. of Tech., Cambridge (USA). Research Lab. of Electronics). 4 Sep 1986. 6p. NTIS, PC A02/MF A01.

A superconducting neutral trap has been constructed and preliminary tests of it have begun. The trap consists of superconducting solenoids to permit slowing and axial confinement and a superconducting octopole magnet for radial confinement in the trap. The trap includes several smaller winding for manipulating trapped atoms. The trap itself is about 40-cm long and has a diameter of 7 cm. It is about 1 Kelvin deep. Na atoms from an atomic beam are to be slowed and then stopped in the center of the trap with counterpropagating laser beams. Initial testing of the magnets, cryogenic vacuum apparatus, and atom source has been completed. A program to optically trap atoms was initiated. This is based on the recent discovery of exceptions to the optical Earnshaw theorem. Several possible traps using only spontaneous forces have been suggested and detailed modelling of these traps is underway. An apparatus to trap atoms based on these new ideas is being conducted.

7629 **(AD-A—171587/9/XAB) Inelastic gas-surface scattering. 2. Results. Technical report.** Stiles, M.D.; Wilkins, J.W. (Cornell Univ., Ithaca, NY (USA). Lab. for Atomic and Solid State Physics). 25 Aug 1986. 118p. (TR—27). NTIS, PC A06/MF A01.

Helium and molecular hydrogen scattering from copper is calculated to examine general features of scattering for these systems, especially the quantum mechanics of the scattering process, both for the motion of the particle and the excitations of the lattice. These calculations use an interaction potential chosen to simplify the numerical calculation while retaining the essential physics of the interaction. The scattering calculations show that these approximations quantitatively reproduce experimental results. The scattering probabilities are shown to depend on details of the system like the well depth and the steepness of the potential and assumptions are made to simplify the interaction potential. $H_2$ and $D_2$ inelastic scattering and trapping probabilities show strong enhancement by selective adsorption resonances and overall changes in scattering intensities due to other more subtle effects of the rotational degrees of freedom. Temperature dependent HD scattering probabilities show the effect of inelastic scattering on rotationally inelastic scattering and selective adsorption resonances.

7630 **(AD-A—171850/1/XAB) Atomic physics research with synchrotron radiation.** Crasemann; Wuilleumier. (Oregon Univ., Eugene (USA). Dept. of Physics). 1985. 37p. NTIS, PC A03/MF A01.

Published in Atomic Energy Physics, 281-315, 1985.

Applications of synchrotron light to research in atomic and molecular physics are reviewed.

**7631 (CENBG—8530) United atom X-rays from nuclear fusion reactions.** Chemin, J.F.; Andriamonje, S.; Guezet, D.; Scheurer, J.N.; Thibaud, J.P.; Aguer, P.; Hannachi, F.; Bruandet, J.F. (Bordeaux-1 Univ., 33 - Gradignan (France). Centre d'Etudes Nucleaires). 1985. 14p. (CONF-850701—11). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750260.

From 14. international conference on the physics of electronic and atomic collisions; Palo Alto, CA, USA (24 Jul 1985).

In the last few years a growing interest has been shown for atomic processes occuring during a nuclear reaction in connection with the possibility of measuring very short nuclear lifetimes. Then difficulty arises to evaluate the probability for creating a vacancy in the K-shell of the CN. We show in this paper that the observation of the x-rays emitted in nuclear fusion reactions gives an unique opportunity to measure the probability for creating a vacancy in the $1s\sigma$ molecular orbital by a direct mechanism. It also gives the contribution of the direct process to the vacancy production in the K-shell of the collision partners. In the first part of the paper we outline the basic principles of the experiment. The experimental details are given in the second part. Then we compare the experimental results to theoretical predictions.

**7632 (CONF-861114—20) Exit charge state dependence of convoy electron production in heavy-ion solid collisions.** Huelskoetter, H.P.; Burgdoerfer, J.; Sellin, I.A. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA)). 1986. Contract AC05-84OR21400. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002176.

From 9. international conference on application of accelerators in research and industry; Denton, TX, USA (10 Nov 1986).

The dependence of the yield of convoy electrons emitted near the forward direction in collisions involving fast ions and thin solid targets on the emergent projectile charge state is presented and described in terms of primary electron loss events in the solid. The data include a large array of projectiles, projectile energies and charge states, as well as targets ranging in thickness from the non-equilibrium well into the equilibrium thickness region. The description presented is consistent with other experimental and theoretical results indicating that the convoy electron production is closely linked to the ELC process observed in binary ion-atom collisions, with the dominant contribution to the convoy yield stemming from excited states of the projectiles. 22 refs., 3 figs.

**7633 (CONF-8409129—, pp 112-118) Infrared multiphoton absorption and decomposition.** Evans, D.K.; McAlpine, R.D. (Atomic Energy of Canada Ltd., Chalk River, Ontario). 1984. NTIS, PC A10/MF A01. File Number DE85007692.

From 3. international conference on multiphoton processes; Iraklion, Crete, Greece (4 Sep 1984).

The discovery of infrared laser induced multiphoton absorption (IRMPA) and decomposition (IRMPD) by Isenor and Richardson in 1971 generated a great deal of interest in these phenomena. This interest was increased with the discovery by Ambartzumian, Letokhov, Ryadbov and Chekalin that isotopically selective IRMPD was possible. One of the first speculations about these phenomena was that it might be possible to excite a particular mode of a molecule with the intense infrared laser beam and cause decomposition or chemical reaction by channels which do not predominate thermally, thus providing new synthetic routes for complex chemicals. The potential applications to isotope separation and novel chemistry stimulated efforts to understand the underlying physics and chemistry of these processes. At ICOMP I, in 1977 and at ICOMP II in 1980, several authors reviewed the current understandings of IRMPA and IRMPD as well as the particular aspect of isotope separation. There continues to be a great deal of effort into understanding IRMPA and IRMPD and we will briefly review some aspects of these efforts with particular emphasis on progress since ICOMP II. 31 references.

**7634 (CONF-8608108—4) What is new in convoy electron physics.** Sellin, I.A. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA)). 1986. Contract AC05-84OR21400. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002193.

From International seminar on dynamic processes of highly charged ions; Susono, Shizuoka-ken, Japan (21 Aug 1986).

In preference to attempting to review the already voluminous literature concerning electron capture (ECC) and loss (ELC) to continuum states in ion-atom and ion-solid collisions - referred to here under the collective term convoy electron production - space and time constraints suggest a wiser course. I choose to focus on the rapid advances in understanding that have occurred in the past year owing to the development of new and powerful techniques for making doubly differential measurements of convoy electron distributions having comparably high resolution in longitudinal and transverse components of electron ejection velocity in the projectile rest frame. 8 refs., 4 figs.

**7635 (CONF-8610115—1) Novel high-resolution experimental approach for studying laser photodetachment in a magnetic field.** Krause, H.F. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002173.

From 4. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (27 Oct 1986).

The need for new high-resolution photodetachment data is discussed. An E-vector x B-vector photoneutralizer concept that is capable of achieving the resolution required for spectroscopic studies is described. Feasibility of the concept has been evaluated in Monte Carlo trajectory studies. The calculations indicate that spectral resolutions in the range 300 to 30 MHz are achievable in a five-parameter coincidence experiment. These bandwidths are 20 to 200 times narrower than have been achieved heretofore in experiments that used the Penning trap technique. Stray electric fields in the E-vector x B-vector photoneutralizer also are much smaller than those in a trap ($< 1/20$). The improved apparatus resolution should allow Landau resonances to be studied at magnetic field strengths well below those used previously. 8 refs., 2 figs.

**7636 (DOE/ER/10371—8) Negative ion detachment cross sections: Progress report, March 1, 1986-February 28, 1987.** Champion, R.L.; Doverspike, L.D. (College of William and Mary, Williamsburg, VA (USA). Dept. of Physics). Nov 1986. Contract AS05-79ER10371. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002430.

Brief descriptions are given for research performed in (1) the electron detachment of alkali negative ions, (2) collisions of negative ions with alkali atoms, (3) charge exchange involving doubly charged ions, and (4) positive ion production in negative ion-atom collisions. (WRF)

**7637 (GSI—86-21-Prepr.) Coupled channel calculations of K-shell ionization in asymmetric collision systems.** Mehler, G.; Greiner, W.; Soff, G. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Inst. fuer Theoretische Physik). Jul 1986. 31p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87750073.

We report theoretical results on K-shell ionization for a variety of asymmetric collision systems. The calculated ionization rates are compared with experimental data. The coupled channel formalism underlying these calculations is presented. It is based on a set of relativistic target centred states, taking a screened potential of Dirac-Fock-Slater type into account. We discuss the effects of different matrix elements, e.g. continuum-continuum couplings. The binding effect is inherently contained in our approach and described in a dynamical way.

**7638 (LUIP—8413) Large-angle light particle correlations in $^{12}C$ induced reactions at 85A MeV.** Kristiansson, P.; Carlen, L.; Gustafsson, H.Aa. (Lund Univ. (Sweden). Dept. of Cosmic and Subatomic Physics; Lund Univ. (Sweden). Dept. of Physics). Dec 1984. 14p. (LUNFD6-NFFK—7052-1-9(1984)). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750162.

Large angle light particle correlations in $^{12}C$ plus $^{12}C$ and $^{12}C$ plus $^{197}Au$ collisions at 85A MeV are observed. An excess of pp correlations in the particle-particle scattering plane is observed

for both reactions whereas for dd correlations it exists only for $^{12}C$ plus $^{12}C$ reactions. Quasi-elastic scattering and emission from a sequentially recoiling thermal source explain the gross structure - but hardly all details - of the pp correlations functions.

7639 **(PB—86-241502/XAB) Physics through the 1990s: atomic, molecular, and optical physics.** (National Research Council, Washington, DC (USA)). 1986. 190p. NTIS, PC A09/MF A01.

See also PB—86-241494; Library of Congress catalog card no. 85-11524.

The volume presents a program of research initiatives in atomic, molecular, and optical physics. The current state of atomic, molecular, and optical physics in the US is examined with respect to demographics, education patterns, applications, and the US economy. Recommendations are made for each field, with discussions of their histories and the relevance of the research to government agencies. The section on atomic physics includes atomic theory, structure, and dynamics; accelerator-based atomic physics; and large facilities. The section on molecular physics includes spectroscopy, scattering theory and experiment, and the dynamics of chemical reactions. The section on optical physics discusses lasers, laser spectroscopy, and quantum optics and coherence. A section elucidates interfaces between the three fields and astrophysics, condensed matter physics, surface science, plasma physics, atmospheric physics, and nuclear physics. Another section shows applications of the three fields in ultra-precise measurements, fusion, national security, materials, medicine, and other topics.

7640 **(UCRL—94615) Electric field gradient and its temperature dependence at $^{111}Cd$ in $\alpha$-uranium.** Huetten, U.; Vianden, R.; Kaufmann, E.N. (Lawrence Livermore National Lab., CA (USA); Bonn Univ. (Germany, F.R.). Inst. fuer Strahlen- und Kernphysik). 30 Sep 1986. Contract W-7405-ENG-48. 5p. (CONF-860918—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002161.

From 7. international conference on hyperfine interactions; Bangalore, India (8 Sep 1986).

The magnitude and temperature dependence of the quadrupole interaction at the $^{111}Cd$ site in orthorhombic $\alpha$-uranium was investigated between 293 and 17 K. The parent activity $^{111}In$ was implanted into uranium metal with an energy of 80 keV and the $\gamma$-$\gamma$ TDPAC technique, applied to the 245 keV state in $^{111}Cd$, was used to measure the quadrupole interaction frequency. The derived electric field gradient for Cd in uranium was found to be highly asymmetric (eta = 1) and led to a quadrupole interaction frequency of /sub Q/ = 7.10(7) MHz at 293 K. The temperature dependence of the quadrupole interaction is very strong, /sub Q/ increases to 14.3(2) MHz at 17 K and shows a linear dependence on the temperature. 10 refs., 2 figs.

7641 **Comment on "Shortening of electron conduction pulses by electron attachers $O_2$, $N_2O$, and $CF_4$" [J. Appl. Phys. 56, 3169 (1984)].** Hunter, S.R. (Atomic, Molecular, and High Voltage Physics Group, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Applied Physics;* 60: No. 12, 4335-4337(15 Dec 1986). Contract AC05-84OR21400.

Negative ion formation in pure $CF_4$ and $CF_4/N_2$ gas mixtures is shown to proceed exclusively by dissociative electron attachment mechanisms at electron energies >4 eV in a high-pressure electron swarm experiment. These results are in contrast to a recent swarm study where $CF_4$ was reportedly shown to attach electrons by transient parent anion formation processes at low electron energies $\epsilon \approx 0.5$ eV. Possible sources of errors in that study are discussed.

7642 **Measurement of the low energy stereostructure of protonated acetylene, $C_2H^+_3$.** Kanter, E.P.; Vager, Z.; Both, G.; Zajfman, D. (Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* 85: No. 12, 7487-7488(15 Dec 1986). Contract W-31-109-ENG-38.

A new experimental method for obtaining detailed structural information on small polyatomic molecular ions is presented. The low-energy structure of protonated acetylene has been studied using this method.(AIP)

7643 **Laser-induced third-harmonic generation in forbidden regions.** Blazewicz, P.R.; Payne, M.G.; Garrett, W.R.; Miller, J.C. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] A: General Physics;* 34: No. 6, 5171-5174(Dec 1986). Contract AC05-84OR21400.

New observations are reported of tunable vacuum ultraviolet light generated in the forbidden region to the red of the xenon $6s'[(1/2)]_1^0$ state due to the introduction of a second, resonant laser field. Striking observations of double-resonant ionization signals on the blue side of the xenon 6s' level are also reported. Both sets of data are interpreted in terms of the changes in phase matching and the nonlinear susceptibility induced in the medium by the second laser. These changes are successfully analyzed in terms of the ac Stark effect in the three-photon level due to the second laser field.

7644 **Electron-impact excitation of ions in the magnesium sequence. II. S V, Ar VII, Ca IX, Cr XIII, and Ni XVII.** Christensen, R.B.; Norcross, D.W.; Pradhan, A.K. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80309-0440). *Physical Review [Section] A: General Physics;* 34: No. 6, 4704-4715(Dec 1986).

Collision strengths are presented for all transitions between the states (including fine structure) $3s^2\,^1S_0$, $3s3p(\,^3P/sub\ 0,1,2/,\,^1P_1)$, $3p^2(\,^3P/sub\ 0,1,2/,\,^1D_2,\,^1S_0)$, $3s3d(\,^3D/sub\ 1,2,3/,\,^1D_2)$, and $3s4s(\,^3S_1,\,^1S_0)$ in Mg-like ions S V, Ar VII, Ca IX, Cr XIII, and Ni XVII. The calculations are carried out in LS coupling using the distorted-wave approximation with a ten-state eigenfunction expansion. Relativistic effects in the target states are taken into account using the Breit-Pauli Hamiltonian, and the term-coupling coefficients thereby obtained are employed to accomplish the transformation of the scattering matrices to intermediate coupling. Atomic effects involving autoionizing resonances in some transitions are considered, as well as the contribution of high partial waves to the transition $3s^2\,^1S_0$—$3s3d\,^1D_2$. The problem of bound-channel correlation-type functions in the eigenfunction expansion is discussed in some detail.

7645 **Spectra and energy levels of Br X-smcapsX-smcapsV-smcaps, Br XX-smcapsI-smcapsX-smcaps, Br XX-smcapsX-smcaps, and Br X-smcapsX-smcapsX-smcapsI-smcaps.** Feldman, U.; Seely, J.F.; Brown, C.M.; Ekberg, J.O.; Richardson, M.C.; Behring, W.E.; Reader, J. (E.O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375-5000). *Journal of the Optical Society of America B: Optical Physics;* 3: No. 11, 1605-1608(Nov 1986).

Emission lines of highly ionized bromine in the wavelength region 17-93 A have been identified in spectra recorded at the University of Rochester's OMEGA laser facility. The wavelengths of 2s-2p transitions in nitrogen-like Br X-smcapsX-smcapsI-smcapsX-smcaps, carbon-like Br X-smcapsX-smcapsX-smcaps, and boron-like Br X-smcapsX-smcapsX-smcapsI-smcaps are presented. The wavelengths of the magnetic dipole transitions within the $2s^22p^3$ ground configurations of Br X-smcapsX-smcapsI-smcapsX-smcaps are predicted from the experimental energy levels. Transitions from the n = 4 and 5 levels of sodium-like Br X-smcapsX-smcapsV-smcaps were also identified, and the ionization energy of Br X-smcapsX-smcapsV-smcaps was determined to be 9,023,800 +- 2 $000cm^{-1}$ (1118.8 +- 0.2 eV).

7646 **Abnormal peak asymmetry in ac Stark doublets due to pressure broadening.** Lau, A.M.F. (Sandia National Labs., Livermore, CA 94550). pp 114 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

This paper reports excellent agreement between theory and Goldsmith's unexpected observation of two-peaked resonance structures in the multiphoton excitation spectra of hydrogen atoms in a hydrogen-air diffusion flame. The authors show that the phenomenon is ac Stark (or Autler-Townes) splitting with abnormal peak

asymmetry. This is the first study demonstrating that the peak asymmetry in an ac Stark doublet is reversed due to pressure broadening.

## 6404 Fluid Physics

*REFER ALSO TO CITATION(S) 7794*

**7647 (AD-A—171900/4/XAB) Advanced diagnostics for reacting flows. Annual scientific report, 1 October 1984-30 September 1985.** Hanson, R.K. (Stanford Univ., CA (USA). High Temperature Gasdynamics Lab.). 11 Oct 1985. 63p. NTIS, PC A04/MF A01.

Original contains color plates: all DTIC and NTIS reproductions will be in black and white.

Progress is reported for the past year of an interdisciplinary program to innovate modern diagnostic techniques applicable to combustion and plasma flows. Research topics include: (1) digital flowfield imaging, including temporally and spatially resolved species and temperature imaging using planar laser-induced fluorescence (PLIF); (2) quantitative particle imaging in spray flames using planar Mie scattering (PMS); (3) quantitative velocity and pressure imaging using variations of PLIF; (4) advanced solid-state camera/computer systems for high-speed and high-resolution recording, processing and display of flow-image data; (5) fiber-optic absorption/fluorescence sensors employing tunable uv, visible, and IR laser sources for species measurements; (6) laser wavelength-modulation spectroscopy, using rapid-scanning uv, visible, and IR laser sources, for absorption and fluorescence measurements of species, temperature, and absorption line shapes; (7) plasma diagnostics utilizing laser-induced fluorescence and wavelength-modulation techniques; (8) laser interactions with plasmas and combustion gases; and (9) investigation of other new diagnostic concepts.

**7648 (DOE/ER/45131—3) [Physics of pattern formation at liquid interfaces]. Progress report, July 1, 1985-June 30, 1986.** Maher, J.V. (Pittsburgh Univ., PA (USA). Dept. of Physics and Astronomy). 25 Jun 1986. Contract FG02-84ER45131. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002315.

A summary is given of research concerning viscous fingering in Hele-Shaw flow and light scattering by binary liquid gels. 12 refs., 3 figs.

**7649 (PB—86-241528/XAB) Physics through the 1990s: plasmas and fluids.** (National Research Council, Washington, DC (USA)). 1986. 338p. NTIS, PC A15/MF A01.

See also PB—86-241486; Library of Congress catalog card no. 85-10634.

The volume contains recommendations for programs in, and government support of, plasma and fluid physics. Four broad areas are covered: the physics of fluids, general plasma physics, fusion, and space and astrophysical plasmas. In the first section, the accomplishments of fluid physics and a detailed review of its sub-fields, such as combustion, non-Newtonian fluids, turbulence, aerodynamics, and geophysical fluid dynamics, are described. The general plasma physics section deals with the wide scope of the theoretical concepts involved in plasma research, and with the machines: intense beam systems, collective and laser-driven accelerators, and the associated diagnostics. The section on the fusion plasma research program examines confinement and heating systems, such as Tokamaks, magnetic mirrors, and inertial-confinement systems, and several others. Finally, theory and experiment in space and astrophysical plasma research is detailed, ranging from the laboratory to the solar system and beyond. A glossary is included.

**7650 (UCRL—15852) User's manual for "FAST" [Fracturing and Simultaneous Transport] hydrofracture code.** Nilson, R.H.; Peterka, D.L. (S-Cubed, La Jolla, CA (USA)). 15 Aug 1986. Contract W-7405-ENG-48. 99p. (SSS-R—86-7590). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87002476.

FAST (Fracturing and Simultaneous Transport) is a computer code which calculates the speed and extent of hydraulically driven fractures based on a two-dimensional model of solid deformation coupled with a one-dimensional model of fluid flow along a permeable-walled crack. The purpose of the code is to provide engineering accuracy and modular flexibility with a moderate expenditure of set-up time and computer resources. This User's Manual includes a description of the mathematical model and its numerical implementation, along with an explanation of required inputs and operating procedures. Also included is a listing of the source code along with the input files which are used to run a series of test calculations which are compared with available analytical results. 14 refs., 12 figs.

## 6450 High Energy Physics

**7651 (DOE/ER/05096—23) High energy physics: Progress report, March 1, 1986-February 28, 1987.** Phillips, G.C.; Roberts, J.B. Jr.; Bonner, B.E. (Rice Univ., Houston, TX (USA). Bonner Nuclear Labs.). 22 Sep 1986. Contract AS05-76ER05096. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002444.

Results are reported from further analysis of a Fermilab jet experiment, in which jet signals have been observed in proton reactions with He, Be, C, Al, Sn, and Pb. Large hyperon polarization effects are reported from another experiment using a polarized beam. Plans have been developed for an experiment on photoproduction of high p/sub T/ jets. A collaborative experiment was approved for the search for exotic/hybrid mesons. Progress is also reported on hadronic studies with polarized beam and target. Theoretical work elucidating the interpretation of QCD field theories and models is reported. (LEW)

**7652 (PB—86-241460/XAB) Physics through the 1990s: elementary-particle physics.** (National Research Council, Washington, DC (USA)). 1986. 251p. NTIS, PC A12/MF A01.

See also PB—86-241478; Library of Congress catalog card no. 85-15210.

The volume begins with a non-mathematical discussion of the motivation behind, and basic ideas of, elementary-particle physics theory and experiment. The progress over the past two decades with the quark model and unification of the electromagnetic and weak interactions is reviewed. Existing theoretical problems in the field, such as the origin of mass and the unification of the fundamental forces, are detailed, along with experimental programs to test the new theories. Accelerators, instrumentation, and detectors are described for both current and future facilities. Interactions with other areas of both theoretical and applied physics are presented. The sociology of the field is examined regarding the education of graduate students, the organization necessary in large-scale experiments, and the decision-making process involved in high-cost experiments. Finally, conclusions and recommendations for maintaining US excellence in theory and experiment are given. Appendices list both current and planned accelerators, and present statistical data on the US elementary-particle physics program. A glossary is included.

## 6451 Particle Interactions And Properties - Experimental

*REFER ALSO TO CITATION(S) 7058, 7689, 7690*

**7653 (ANL-HEP-CP—86-56) Observation of the decays tau → eta X, tau → ωX.** Abachi, S.; Akerlof, C.; Baringer, P.; Blockus, D.; Brabson, B.; Brom, J.M.; Bylsma, B.G.; Chapman, J.; Cork, B.; DeBonte, R. (Argonne National Lab., IL (USA); Indiana Univ., Bloomington (USA); Lawrence Berkeley Lab., CA (USA); Michigan Univ., Ann Arbor (USA); Purdue Univ., Lafayette, IN (USA)). Jun 1986. Contract W-31-109-ENG-38. 15p. (IUHEE—385; UM-HE—86-12; PU—86-569; CONF-860701—44). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001500.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

In a study of tau lepton decay using the High Resolution Spectrometer at the PEP storage ring, the inclusive production of

the rho, ω, and eta mesons has been observed. The data sample corresponds to an integrated luminosity of 300 $pb^{-1}$ and the storage ring was operated at $\sqrt{s}$ = 29 GeV. The inclusive branching ratio for tau+ → π+eta X is (8 +- 4)%. This result resolves the current discrepancy between the one-prong topological branching ratio and the sum of the individual one-prong modes.

7654 **(ANL-HEP-CP—86-60) Limit on tau decay to 7-charged tracks.** Abachi, S.; Akerlof, C.; Baringer, P.; Blockus, D.; Brabson, B.; Brom, J.M.; Bylsma, B.G.; Chapman, J.; Cork, B.; De Bonte, R. (Argonne National Lab., IL (USA); Indiana Univ., Bloomington (USA); Lawrence Berkeley Lab., CA (USA); Michigan Univ., Ann Arbor (USA); Purdue Univ., Lafayette, IN (USA)). 1986. Contract AC03-76SF00515;AC03-76SF00098;W-31-109-ENG-38. 12p. (CONF-860701—36). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001549.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Using the complete data sample of 300 $pb^{-1}$ from $e^+e^-$ collisions at 29 GeV, the HRS collaboration has searched for tau decay to 7 charged particles and any number of neutrals. No events were found. The corresponding upper limit to the branching ratio is B(tau → 7π+− + nγ + nu/sub tau/) < 3.8 x $10^{-4}$ at 90% confidence level. Using the final HRS data sample we also report updated branching ratios for tau → 5π+− + nu/sub tau/ and tau → 5π+− + π0 + nu/sub tau/.

7655 **(ANL-HEP-CP—86-75) Charm D production in $e^+e^-$ annihilation at 29 GeV.** Abachi, S.; Akerlof, C.; Baringer, P.; Blockus, D.; Brabson, B.; Brom, J.M.; Bylsma, B.G.; Chapman, J.; Cork, B.; DeBonte, R. (Argonne National Lab., IL (USA); Indiana Univ., Bloomington (USA); Lawrence Berkeley Lab., CA (USA); Michigan Univ., Ann Arbor (USA); Purdue Univ., Lafayette, IN (USA)). 1986. Contract AC02-76ER01112;AC03-76SF00098;W-31-109-ENG-38;AC02-76ER01428;AC02-84ER40125. 24p. (CONF-860701—38). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001546.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Results are presented on the analysis of charm D Production from 300 $pb^{-1}$ of data taken with the HRS Detector at PEP. The electroweak asymmetry is -8.4 +- 3.6% and R (D + D*) = 1.57 +- 0.17. Fragmentation functions for $D^0$, $D^+$, $D^{*+}$ production and the results of a search for the D** are given. 10 refs., 9 figs.

7656 **(ANL-HEP-CP—86-98) Simple example of track finding by Fourier transform and possibilities for vector or optical processors.** Underwood, D. (Argonne National Lab., IL (USA)). 5 Sep 1986. Contract W-31-109-ENG-38. 7p. (CONF-8606215—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001563.

From Summer study on the physics of the superconducting super collider; Snowmass, CO, USA (23 Jun 1986).

Simple examples of finding tracks by Fourier transform with filter or correlation function are presented. Possibilities for using this method in more complicated real situations and the processing times which might be achieved are discussed. The method imitates the simplest examples in the literature on optical pattern recognition and optical processing. The possible benefits of the method are in speed of processing in the optical Fourier transform wherein an entire picture is processed simultaneously. The speed of a computer vector processor may be competitive with present electro-optical devices. 2 refs., 6 figs.

7657 **(BNL—38767) $Sin^2L$/sub W/ and radiative corrections.** Marciano, W.J. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 5p. (CONF-860701—39). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002151.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Precision measurements of $sin^2\theta$/sub W/ and the effects of radiative corrections are surveyed. A world average $sin^2\theta$/sub W/ = 0.229 +- 0.004 is obtained. Comparison of deep-inelastic ν/sub μ/N scattering and m/sub W/ or m/sub Z/ is shown to test the standard model at the quantum loop level and constrain new physics. Implications for grand unified theories are briefly discussed.

7658 **(DOE/ER/03244—126) Strangeness production with antiprotons.** Barnes, P.D.; Maher, C.J. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)). May 1986. Contract AC02-76ER03244. 12p. (CONF-860575—59). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002035.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

New data from LEAR on the production of hyperon-antihyperon pairs in strong interactions is reported. The possibility of checking CP invariance in the anti ΛΛ system is reviewed together with plans to search for the ξ(2230) in the rho + anti rho → K/sub s/ + anti K/sub s/ reaction. 21 refs., 9 figs., 1 tab.

7659 **(DOE/ER/40143—3) Theoretical studies in few-body intermediate energy physics: Progress report, March 1, 1986-February 28, 1987.** Mizutani, T. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Oct 1986. Contract FG05-84ER40143. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002439.

Research topics include studies with systems of two nucleons above the threshold of single pion production. Efforts have been directed towards πd elastic and NN→NN channels with the field theory of mesons and baryons. Additional research considers deuteron photodisintegration and pion photo-production on deuteron in the delta resonance region and low energy proton-antiproton interactions (proton + antiproton → Lambda + antilambda). (DWL)

7660 **(LAL—85-14) Study of direct photon production in hadronic interactions.** Cohen, M. (Paris-11 Univ., 91 - Orsay (France). Lab. de l'Accelerateur Lineaire). May 1985. 188p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE87750285.

We present in this thesis the results obtained by the NA3 experiment at the CERN SPS, on high transverse momentum prompt photon production with $\pi^+$, $\pi^-$ and p beams on a carbon target at $\sqrt{s}$ = 19.4 GeV. The main difficulty of this experiment comes from the high background from $\pi^0$ and eta decays. We present the measurements of inclusive $\pi^0$ cross sections between Psub(T) = 3.8 GeV/c and Psub(T) = 5.8 GeV/c for $\pi^+$, $\pi^-$, p, $K^+$ and $K^-$ incoming particles. The contamination to the prompt photon signal is estimated and subtracted trough a Monte-Carlo simulation. A clear prompt photon signal is seen. The observed cross-sections are in good agreement with QCD predictions computed at the second order. The difference between $\pi^-$ and $\pi^-$ induced cross-sections which reveals the contribution of the annihilation graph qanti-q → γg is found to be small and in good agreement with theoretical predictions.

7661 **Chi/sub b/ states in exclusive radiative decay of the Y(2S).** Walk, W.; Zschorsch, P.; Antreasyan, D.; Aschman, D.; Besset, D.; Bienlein, J.K.; Bloom, E.D.; Brock, I.; Cabenda, R.; Cartacci, A. (California Institute of Technology, Pasadena, California 91125). *Physical Review* [*Section*] *D: Particles and Fields;* **34**: No. 9, 2611-2620(1 Nov 1986).

The Crystal Ball detector at the DESY storage ring DORIS II has been used to study radiative decays of the Y(2S) resonance. We report on the analysis of the exclusive channel Y(2S)→γchi/sub b/, chi/sub b/→γY(1S)→$e^+e^-$ or $\mu^+\mu^-$. We detect two chi/sub b/ states by observing two monochromatic photon lines at energies (107.0 +- 1.1 +- 1.3) MeV and (131.7 +- 0.9 +- 1.3) MeV, respectively. The product branching ratios B[Y(2S)→γchi/sub b/] x B[chi/sub b/→γY(1S) ] are (1.6 +- 0.3 +- 0.2)% for the first state and (2.1 +- 0.3 +- 0.3)% for the second. For the product branching ratio of the third chi/sub b/ state, which has been observed in inclusive measurements, we find an upper limit of 0.2% (90% C.L.). Combining our results with inclusive measurements, branching ratios for chi/sub b/→γY(1S) are derived. Using theoretical estimates for the radiative widths of the chi/sub b/ states, we determine their hadronic widths; the results are compared with QCD predictions.

**7662 Measurement of the $D^0$ and $D^+$ lifetimes.** Gladney, L.; Jaros, J.A.; Ong, R.A.; Barklow, T.; Boyarski, A.M.; Breidenbach, M.; Burchat, P.; Burke, D.L.; Dorfan, J.M.; Feldman, G.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review [Section] D: Particles and Fields;* **34**: No. 9, 2601-2610(1 Nov 1986). Contract AC03-76SF00515;AC03-76SF00098;AC02-76ER03064.

We have used a high-resolution drift chamber in the Mark II detector at the SLAC $e^+e^-$ storage ring PEP to measure the lifetimes of the $D^0$ and $D^+$ mesons produced in $e^+e^-$ annihilations at 29 GeV. Based on a sample of 74 decays for the $D^0$ mesons and 23 decays for the $D^+$ mesons, the lifetimes are found to be tau/sub D//sub =/ = (4.7/sub -0.8//sup +0.9/) +- 0.5 x 10/sup -13/ sec and tau/sub D//sub =/ = (8.9/sub -2.7//sup +3.8/) +- 1.3 x 10/sup -13/ sec. This leads to a ratio of lifetimes tau/sub D//sub =// tau/sub =/ = 1.9/sub -0.7/ /sup +0.9/ +- 0.3. .AE

**7663 Observation of tensor and scalar mesons produced in $e^+e^-$ annihilation at 29 GeV.** Abachi, S.; Baringer, P.; Bylsma, B.G.; DeBonte, R.; Koltick, D.; Loeffler, F.J.; Low, E.H.; McIlwain, R.L.; Miller, D.H.; Ng, C.R. (Purdue University, West Lafayette, Indiana 47907). *Physical Review Letters;* **57**: No. 16, 1990-1993(20 Oct 1986).

The production of the tensor mesons f°(1270) and K/sup */ °(1430) and the scalar meson S(975) have been observed in $e^+e^-$ annihilation at 29 GeV center-of-mass energy, by use of data obtained with the High-Resolution Spectrometer at the storage ring SLAC $e^+e^-$ PEP. The mean multiplicities for meson momenta greater than 1450 MeV/c are <n/sub f//sub =/> = 0.11 +- 0.04, <n/sub K//sub <//sub */₀(1430)$> = 0.10 +- 0.0 6, and <n/sub S/> = 0.05 +- 0.02 per hadronic event. The fragmentation functions of the tensor mesons are in good agreement with the predictions of the Webber cluster model. The data are consistent with a predominant strange-quark content of the S meson.

**7664 Measurement of the Σp magnetic moment using the $\Sigma^-\to ne^-$ nu-bar and $\Sigma^-\to n\pi^-$ decay modes.** Zapalac, G.; Hsueh, S.Y.; Muller, D.; Tang, J.; Winston, R.; Swallow, E.C.; Berge, J.P.; Brenner, A.E.; Grafstroem, P.; Jastrzembski, E. (Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637). *Physical Review Letters;* **57**: No. 13, 1526-1529(29 Sep 1986).

We have used the spin-precession technique to measure the $\Sigma^-$ magnetic moment (μ/sub Σ/). A $\Sigma^-$ beam with a polarization of 22% was produced by a 400-GeV proton beam striking a Cu target at nominal production angles of +- 3 mrad. We simultaneously recorded 21X0 $\Sigma^-\to ne^-$ nu-bar decays and 650X0 $\Sigma^-\to n\pi^-$ decays at $\Sigma^-$ beam momenta of 253 and 308 GeV/c. We find that μ/sub Σ/ = -1.166 +- 0.014 +- 0.010 nuclear magnetons, where the quoted errors are statistical and systematic, respectively.

**7665 Measurement of π/sup -/p->K/sub s//sup 0/K/sub s//sup 0/n at 22 GeV/c and a systematic study of the 2/sup ++/ meson spectrum.** Longacre, R.S.; Etkin, A.; Foley, K.J.; Love, W.A.; Morris, T.W.; Saulys, A.C.; Platner, E.D.; Lindenbaum, S.J.; Bensinger, J.R.; Kirsch, L.E. (Brookhaven National Lab., Upton, NY, USA; City Coll., New York, USA). *Physics Letters [Section] B;* **177**: No. 2, 223-227(11 Sep 1986). Contract AC02-76CH00016;AC02-76ER03230;AC02-83ER40107;AS05-76ER03065.

A coupled channel analysis has been carried out using a new amplitude analysis of the K/sub s//sup 0/K/sub s//sup 0/ system produced in the reaction π/sup -/p->K/sub s//sup 0/K/sub s//sup 0/n at 22 GeV/c, which contained about 40000 new events in the low-t region (t-t/sub min/<0.1 GeV/sup 2/). Here only the I/sup G/=0/sup +/, J/sup PC/=2/sup ++/ amplitude from this analysis is considered, together with available data from other experiments in channels with the same quantum numbers in order to determine which 2/sup ++/ isoscalar mesons have significant pseudoscalar-pseudoscalar couplings. It is found that four poles, f(1270), f'(1525), θ(1690), and f/sub r/(1810), are needed, plus a smooth background in order to fit these data; the need for the θ(1690) depends on the J/{PSI} radiative decay alone, and the f/sub r/(1810) is seen only in hadronic production.

**7666 Monopoles, cosmology, and astrophysics: Update 1985.** Turner, M.S. (NASA/Fermilab Astrophysics Center, Fermi National Accelerator Lab., Batavia, IL). pp 639-651 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The superheavy magnetic monopoles predicted by unified theories remain extremely interesting and enigmatic objects. They offer one of the few windows to physics at energies much greater than 1 TeV and to the earliest moments of the universe (t ≲ 10-/sup 34/sec). Theory still provides no useful or reliable prediction of their relic abundance, and the very stringent astrophysical bounds based upon the survival of astrophysical magnetic fields and catalysis of nucleon decay in neutron stars remain intact after very careful scrutiny. In this paper, the author presents a brief review of the current situation, a situation that has not changed appreciably in the past few years.

**7667 Status of double beta decay.** Witherell, M.S. (Dept. of Physics, Univ. of California, Santa Barbara, Santa Barbara, CA). pp 577-581 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The status of double beta decay is discussed in this paper. The most sensitive test of lepton number violations in the neutrino system is neutrinoless double beta decay. In particular, the limit for the half-life of this process in /sup 76/Ge has been pushed from 5 X 10/sup 21/ years to about 10/sup 23/ years. Within another year, another factor of five to ten in improvement can be expected. The present limit corresponds to a Majorana neutrino mass of around 5 eV, if present calculations are right. To reduce the uncertainty in the calculations, the lifetime for two-neutrino double beta decay must be well measured in a nucleus in which the calculation of the matrix element should be reliable. To go beyond the limit of about 10/sup 24/ years requires a breakthrough in experimental technique. Many groups are investigating the use of large volume wire chambers filled with /sup 136/Xe, which has a 2.5 MeV energy for double beta decay. A novel approach has been previously suggested for using low temperature calorimetry. One of these, or another new approach, will be necessary to carry the search for lepton number violation in neutrinos further.

**7668 The SLC program.** Prescott, C.V. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA). pp 476-486 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—). Contract AC03-76SF00515.

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

This paper discusses the SLC program. The SLC proposal was conceived as a prototype of a new class of particle accelerators, specifically the linear colliders. The desires for higher energy e/sup +/ e/sup -/ collisions were based on the highly successful e/sup +/ e/sup -/ physics programs at existing machines and the promise of exciting physics experiments at higher energies. Scaling of storage ring parameters to reach higher energies led to designs of very large machines and estimates of very costly projects. The SLAC Linear Collider proposal was an economical step to achieve the next increment in energy that seemed appropriate, namely that needed to reach the Z/sup 0/. To achieve economically the desired luminosity, comparable to that possible in a scaled-up storage ring, the small beam size and short duty cycle capabilities of a linac were exploited. Modifications of the existing SLAC linac were required.

**7669 A selective experimental review of the standard model.** Bloom, E.D. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA). pp 384-414 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

Before discussing experimental comparisons with the "Standard Model" (S-M), the author defines what is commonly meant by this popular term. This model is a gauge theory of SU(3)/sub f/ X SU(2)/sub L/ XU(1) with 18 parameters. The present S-M covers an enormous range of physics topics and, therefore, the author only covers a few such topics in this report. The measurement of R/sub hadron/ is fundamental as a test of the running coupling constant $\alpha$/sub s/, in QCD. The author discusses a selection of recent "precision" measurements of R/sub hadron/, as well as some other techniques for measuring $\alpha$/sub s/. QCD also requires the self-interaction of gluons. The search for the three gluon vertex may practically be realized in the clear identification of gluonic mesons. The author presents a limited review of recent progress in the attempt to untangle such mesons from the plethora of qq-bar states of the same quantum numbers that exist in the same mass range. The electroweak interactions provide some of the strongest evidence supporting the S-M that exists. Given the recent progress in this subfield and particularly with the discovery of the W and Z bosons at CERN,/sup 3/ many recent reviews obviate the need for further discussion in this report. Finally, the author examines recent searches for new particle states.

7670 **Detector problems at the SSC.** Wojcicki, S.G. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA). pp 351-366 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—). Contract AC03-76SF00515;AC03-81ER40050.

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

During the last couple of years, there has been considerable concern expressed among the U.S. high energy community as to whether detector limitations would prevent one from being able to fully exploit a luminosity of 10/sup 33/ cm/sup -2/ sec/sup -1/ at a hadron-hadron high energy collider. As a result of these concerns, a considerable amount of work has been done recently in trying to understand the nature of potential difficulties and the required R & D that needs to be performed. This paper attempts to review some of these results. This work is limited to the discussion of detector problems associated with the study of high energy hadron-hadron collisions. Even though there have been considerations of other possible future options for the SSC, like e/sup -/p and fixed target capability, the detector questions for these options are quite different and will not be considered here. The authors start with a discussion of the desirable features of the detectors and of the SSC environment in which they will have to work. After a brief discussion of the model $4\pi$ detectors, they discuss specific detector aspects: lepton identification, tracking, calorimetry, and computing and triggering. The authors end with some remarks about the possible future course of events.

7671 **The standard model and beyond.** Marciano, W.J. (Dept. of Physics, Brookhaven National Lab., Upton, NY). pp 367-383 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—). Contract AC02-76CH00016.

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The present status and future possibilities for the standard model are reviewed. The standard model is in very good shape. Discovery of the W/sup +-/ and Z, along with measurements of their masses and decay properties, provides the best confirmation of that theory to date. The electroweak sector is already starting to be tested at the level of its quantum loop corrections. There still remain, of course, areas where experimental verification of the standard model is imperative. In the QCD sector, one would like to find and investigate glueballs as well as other predicted exotic states. Direct evidence for the running of $\alpha$/sub 3/($\mu$), precise determination of $\Lambda$(4)/MS, and a better understanding of confinement and chiral symmetry breaking are also on the agenda. Perhaps the most important recent development in low energy experimental physics is the advent of big underground proton decay detectors. After more than a year of data taking, the IMB collaboration has set very constraining limits on a large number of proton and neutron decay modes. These bounds constrain GUTS and indicate the need for new physics between m/sub w/ and unification. Exciting high energy experiments now under way are UA1 and UA2 at CERN. Monojet events detected by the UA1 collaboration seem to be inconsistent with standard model backgrounds and have naturally created considerable excitement. Supersymmetry, technicolor, and composite model advocates all have competing explanations.

7672 **Some comments on SSC physics.** Hinchliffe, I. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA). pp 336-350 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—). Contract AC03-76SF00098.

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

In this paper, the author discusses some topics relevant to the physics of the SSC. The authors first discusses the reliability of predictions for event rates at the SSC and then discusses the status of proposals to search for the minimal Weinberg-Salam model Higgs boson.

7673 **Cross sections in the multi-TeV range.** Gaisser, T.K.; Halzen, F. (Dept. of Physics, Univ. of Wisconsin, Madison, WI). pp 260-268 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

Interpretation of air shower experiments to extract the cross section in the 40 TeV range depends on the model of hadronic interactions used to simulate the experiments. The authors argue that if the observed scaling violations in hadronic collisions are associated with the hard scattering of constituent partons, then the scaling violations will be confined largely to the central region and will have little effect on the cross section determination. The only way at present to study hadronic cross sections at $\sqrt{s} \approx 50$ TeV is with cosmic rays. The flux at this energy is of the order, one per km/sup 2/ per week, so direct observation of the primaries is out of the question and one must resort to ground-based air shower arrays with large areas exposed for long times. Since the primary particles and the initial interactions are not then directly observed (but only their products deep in the atmosphere), it is necessary to assume a model of hadronic interactions to interpret the data. Moreover, the chemical composition of the primary nuclei is not directly observed either. Thus, cross section and composition of the beam must be determined from the same data.

7674 **Rare psi decays.** Partridge, R. (Institute for Particle Physics, Univ. of California, Santa Cruz, CA). pp 546-563 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

Slightly more than ten years have passed since the psi was discovered, yet the study of psi decays continues to be an active and fruitful area of research. One reason for such longevity is that each successive experiment has increased their sensitivity over previous experiments either by improving detection efficiency or by increasing statistics. This has allowed the observation and, in some cases, detailed studies of rare psi decays. Branching ratios of $\approx$10-/sup 4/ are now routinely studied, while certain decay channels are beginning to show interesting effects at the 10-/sup 5/ level. Future experiments at the Beijing Electron Positron Collider (BEPC) have the potential for increasing sensitivities by one or two orders of magnitude, thus enabling many interesting studies impossible with current data samples. The author first examines the extent to which psi decays can be used to study electroweak phenomena. The remainder of this work is devoted to the more traditional task of using the psi to study quarks, gluons, and the properties of the strong interaction. Of particular interest is the study of radioactive psi decays, where a number of new particles have been discovered. Recent results regarding two of these particles, the $\theta$(1700) and iota(1450), are discussed, as well as a study of the quark content of

the eta and eta' using decays of the psi to vector-pseudoscalar final states.

**7675 Measurements of neutrino mass.** Robertson, R.G.H. (Physics Div., Los Alamos National Lab., Los Alamos, NM). pp 564-576 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

In this review, the authors consider "direct" experimental information on neutrino mass as derived from the study of nuclear and elementary-particle weak decays. Neutrino oscillations, double $\beta$ decay, and searches for heavy neutrinos admixed with lighter ones are not discussed since they are given extensive treatment by others. Similarly, only cursory consideration are given to cosmological limits on neutrino mass.

**7676 Brief review of neutrino physics.** Sciulli, F. (Dept. of Physics, Columbia Univ., New York, NY). pp 415 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

This paper provides a brief review of neutrino physics. The running of the coupling constant, $\alpha_s$, predicted by QCD is not seen presently by using measurements of R/sub hadron/. However, the systematic errors on the measurements still allow a running $\alpha_s$. It should be noted that when calculating $\alpha_s$ at the J/psi and Y using the technique of a previous work, a running $\alpha_s$ is also not observed, but is allowed within error. Evidence for the three gluon coupling predicted by QCD is still lacking. The search for gluonic mesons has continued to be inconclusive, even though candidate meson properties have been considerably refined. Searches for right-handed currents have so far proved negative, though impressive mass limits have been obtained. Searches for supersymmetric particles have also proved negative, with mass limits strongly coupled to accelerator energy. Much enthusiasm and inventiveness has been generated by the announcement of two possible new states, $\xi$ and zeta however, the existence of these states is presently uncertain. In the case of the zeta, theoretical interpretation outside the S-M played a very prominent role.

**7677 The phenomenology of high energy multijets in hadron-hadron collisions.** Field, R.D. (Dept. of Physics, Univ. of Florida, Gainesville, FL). pp 38-55 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The results of one particular QCD Monte Carlo model for hadron-hadron collisions with the predictions of the "naive 4-jet" patron model are composed in this paper. In the naive parton model, high transverse momentum particles are produced by a single, hard, large-angle elastic scattering of partons; one from the target hadron and one from the beam hadron. A large $p_T$ event consists of four jets. The two outgoing partons fragment into two jets with roughly equal and opposite transverse momentum. The other two jets have small transverse momentum and result from the breakup of the beam and target hadrons. One can account for this breakup by assigning the "hole," which is left in the beam and target hadron when the scattered patron is removed, the remaining momentum and allowing it also to fragment into a jet. The QCD Monte Carlo model used is similar to the naive parton model, but it includes some important QCD corrections. In addition to the $2 \rightarrow 2$ parton-parton hard scattering subprocesses, complicated $2 \rightarrow N$ subprocesses are estimated by including the noncollinear emission of gluons off both the initial- and final-state partons in the "leading pole" approximation.

**7678 Measurement of the semileptonic decay of B mesons into muons.** Levman, G.; Sreedhar, V.; Han, K.; Imlay, R.; Metcalf, W.; Dietl, H.; Eigen, G.; Fonseca, V.; Lorenz, E.; Mageras, G.; Pauss, F. (Louisiana State Univ., Baton Rouge). *Physics Letters [Section] B;* 141B: No. 3-4, 271-275(28 Jun 1984). Contract AS05-77ER05490.

The authors have observed muons from the semileptonic decay $B \rightarrow Xuv$ where B mesons are produced in $e^+e^-$ annihilation into hadrons at the Upsilon(4S) resonance (10.58 GeV). The authors obtain a branching ratio of $(11.2 = 0.9 = 1.0)\%$ for $B \rightarrow X/$ sub uv/. The authors have also measured the production of energetic muons in hadronic $e^+e^-$ annihilations in the energy region above the Upsilon(4S) from 10.6 GeV to 11.2 GeV. 18 references, 2 figures, 2 tables.

## 6452 Particle Interactions And Properties - Theoretical

*REFER ALSO TO CITATION(S) 7571, 7669, 7671, 7676, 7676, 7677, 7700*

**7679 (ANL-HEP-CP—86-82) Effects on spin asymmetries of special effects at 90°.** Lipkin, H.J. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 9p. (CONF-860575—57). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001571.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

Hadron and quark exchange contributions to spin symmetries at 90° in hadron elastic scattering are investigated. The angular distribution of scattering cross sections is considered for incident protons with contributions from nonflip and double-flip amplitudes for states of parallel and antiparallel spins. 5 refs.

**7680 (CEA-CONF—8241) Theoretical status of the operator product expansion.** David, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jul 1985. 16p. (CONF-8507137—1; SPhT—185-174). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750255.

From Conference on non-perturbation methods; Montpellier, France (9 Jul 1985).

The theoretical status of the operator product expansion in asymptotically free theories is reviewed. The role of renormalon singularities in this expansion is stressed and the relationship of these problems with the applications of the O.P.E. to hadronic physics is discussed.

**7681 (DOE/ER/40219—2) [Research in theoretical physics]: Annual performance report, [1986].** (North Carolina Univ., Chapel Hill (USA)). 1986. Contract FG05-85ER40219. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002438.

Results are reported in the areas of: chiral fermions and anomalies, superstring finiteness, superstring phenomenology, spin splittings in heavy quarkonia, low-energy limits of superstring, a supersymmetric electroweak model with a light squark, scalar quark bound states, fermionic tachyons and Poincare representations, relativistic dynamics of spin-one particles and deuteron-nucleus scattering, interactions involving higher spin massless particles, and classical action at a distance theories which contain a cutoff. (LEW)

**7682 (DOE/ER/40238—1, pp 3824-3827) Physics opportunities with relativistic heavy ion accelerators.** Samios, N.P. (Brookhaven National Lab., Upton, NY). 1985. IEEE, 345 East 47th St., New York, NY 10017. File Number TI86011479. (CONF-850504—Pt.2).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

The interest and excitement in the study of relativistic heavy ion interactions has been steadily increasing over the past several years. The reasons are varied; however, the opportunity to enter into a new realm of physics where the theoretical predictions indicate promise of new phenomena must be a major factor. The authors as physicists are always enticed by new and novel ideas. To be a bit more precise, the physics motivation for a relativistic heavy

ion collider with energies of 100 GeV/Amu x 100 Gev/Amu for nuclei of A-200 are, i) this will allow the production in the laboratory of a new state of matter - the quark gluon plasma, ii) the study of such interactions will provide an experimental test of statistical quantum chromodynamics (QCD), i.e., a look at the properties of the QCD vacuum at large distances, iii) such reactions will simulate the conditions of the early universe and, iv) such a collider will allow them to delve into the unknown. If history is any guide then it is clear that any time one can increase an important physics parameter by a factor of 10 (and in this case a factor of 100 over what is presently being done) then you do it! At present the Bevalac at Berkeley is the premier facility for the study of heavy ions with a center of mass capability of 1 GeV/Amu x 1 GeV/Amu. In the near term this capability will be increased at the AGS at BNL (6 GeV/Amu x 6 GeV/Amu) and at the CERN SPS (10 GeV/Amu x 10 GeV/Amu).

7683 **(LA-UR—86-3582) NN → NN $\pi$: the new frontier in nucleon-nucleon interactions.** Silbar, R.R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 8p. (CONF-8609163—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001969.

From International conference and symposia on unified concepts of many-body problems; Stony Brook, NY, USA (4 Sep 1986).

The torch in nucleon-nucleon scattering has been passed to experimental and theoretical studies of pion production. Comparing two unitary models shows that most of the structures predicted for spin observables in NN → NN$\pi$ are model independent and roughly in agreement with the data. The contribution of rho- exchange is small, indicating the reaction is largely "peripheral". The energy dependence of these isobar models is smooth. The largely unstudied reactions producing neutral and negatively-charged pions show richer structure than positively-charged pion production. 6 refs.

7684 **(LYCEN—8547) Non-static model for the Roper resonances.** Guichon, P.A.M. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire). Jul 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750258.

We solve the M.I.T. bag equations for Fermions in the limit of small fluctuations and quantize the solution. We get a non static bag model which provides a satisfactory interpretation of the Roper resonances if the time averaged radius of the cavitity is about 1 fm.

7685 **Neutral hadronic eta′ and eta decays and electromagnetic mixing.** Coon, S.A.; McKellar, B.H.J.; Scadron, M.D. (School of Physics, University of Melbourne, Parkville, Victoria, Australia 3052). *Physical Review [Section] D: Particles and Fields;* 34: No. 9, 2784-2789(1 Nov 1986).

We directly determine the electromagnetic mixing of eta, eta′, and $\pi^0$ mesons by analyzing the neutral decays eta→3$\pi^0$, eta′→eta2$\pi^0$, and the recently measured eta′→3$\pi^0$. Our result for the mixing parameters <$\pi^0$chemical bondH/sub em/chemical bondeta>≅-0.0059 +- 0 .0006 GeV² and <$\pi^0$chemical bondH/sub em/chemical bondeta′>≅-0.0055 +- 0.0005 GeV² is relatively insensitive to the semistrong mixing angle of the etaeta′ system and reasonably consistent with tadpole predictions based on the quark model.

7686 **Possible v-quark signatures at $e^+e^-$ colliders.** Barger, V.; Phillips, R.J.N.; Soni, A. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Physical Review Letters;* 57: No. 13, 1518-1521(29 Sep 1986).

We describe distinctive signatures of a possible fourth-generation charge -(1/3) quark v (assumed lighter than the t quark) arising from $e^+e^-$→vv-bar production, especially at the $Z^0$ resonance. We emphasize the special charm and topological characteristics expected from v-quark cascade decays and the possibility of v→b+gluon decays by an effective flavor-changing neutral current.

7687 **Dynamical selection rules in NN-bar annihilation.** Dover, C.B.; Fishbane, P.M.; Furui, S. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review Letters;* 57: No. 13, 1538-1541(29 Sep 1986). Contract AC02-76CH00016;AA03-76SF00034.

Observations of a strong dependence of nucleon-antinucleon annihilation modes, particularly $\pi$rho and $\pi$f, on orbital angular momentum and spin-isospin are interpreted in a quark-gluon description of the reaction dynamics.

7688 **Constraints on iota→$\gamma\gamma$ provided by the topological susceptibility.** Milton, K.A. (Department of Physics and Astronomy, University of Oklahoma, Norman, Oklahoma 73019). *Physical Review Letters;* 57: No. 13, 1530-1533(29 Sep 1986).

The chiral Ward identities for the pseudoscalar nonet including the glueball candidate iota(1450), together with the requirement that the topological susceptibility be positive, imply that Γ(iota→$\gamma\gamma$) is typically small (<1 keV), in agreement with recent experimental values. The topological susceptibility is, as expected, much smaller than pure-gauge-field estimates.

7689 **Charm and heavy flavor lifetimes.** Ford, W.T. (Dept. of Physics, Univ. of Colorado, Boulder, CO). pp 529-545 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The authors have seen that tau-$\mu$ universality is obeyed within ≈8%. In the charm system, lifetimes are in rough agreement with universality at the parton level (within uncertainties in quark masses, etc.) On the other hand, the observed inequalities of tau(D/sup +/)>tau(D/sup 0/,F/sup +/), tau(A/sup +/)≅tau(Λ/sub c//sup +/), indicate either the necessity for exchange and/or annihilation diagrams in the explanation of these decay rates or the inadequacy of the parton plus short-distance QCD description, or both. The bottom lifetime has now been measured by five experiments and is confirmed to be approximately 10/sup -12/ sec. This implies only about 5% mixing of the third with the second generation, to be compared with the sin $\theta$/sub c/ =0.23. Outstanding problems include establishment of the value, presently bounded only from above, of the u-b mixing, and separate B/sup 0/ and B/sup +/ lifetime measurements as a probe of the composite structure of the bottom system, which one hopes because of the larger quark mass will be more easily understood than the charm system in terms of the patron-level physics in short-distance approximation.

7690 **Comments on monojets and other anomalous events.** Kane, G.L. (Randall Physics Lab., Univ. of Michigan, Ann Arbor, MI). pp 269-288 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The standard Model (SM) is increasingly well tested and it continues to describe all experiments to the present limits of accuracy. Most particle physicists hope that phenomena will be found that do not fit the SM predictions, not because it will contradict the SM, but because it will provide clues to physics beyond the SM. There are still many questions whose answers we would like to have, such as why the SM takes the form it does, what is the origin of mass and flavor, can all forces be unified, is supersymmetry (which is an allowed symmetry in a quantum field theory) realized in nature, and more. In recent years, a number of possible effects beyond the SM have been reported, such as Higgs boson candidates with properties inconsistent with a single neutral SM Higgs boson, too large a cross section for production of like-sign dileptons in $\nu$ reactions, several categories of events in the UA1 and UA2 detectors at the CERN collider, and others. Unfortunately, most of them have not stood up to subsequent experimental examination. Of all the candidates at the CERN collider, only the UA1 monojet events (and perhaps some associated dijet events with missing momentum) have become a stronger signal as the data improved statistically and systematically. The author considers some of the kinds of constraints that must apply to any attempts to understand the origins of anomalous events, with an emphasis on high energy colliders. The author then concentrates on the predictions of supersymmetry and whether it can describe the monojet events.

7691 **Bound-state effects in Upsilon → γ + resonance.** Pantaleone, J.; Peskin, M.E.; Tye, S.H.H. (Cornell Univ., Ithaca, NY). *Physics Letters [Section] B;* **149B**: No. 1-3, 225-233(13 Dec 1984). Contract AC03-76SF00515.

The authors study the effect of b anti b bound state dynamics on the amplitude for the reaction upsilon → γ + resonance. The authors argue from their results that the recently discovered zeta (8320) must have a scalar, rather than a pseudoscalar, coupling to the b quark. 30 references, 6 figures, 1 table.

## 6453 Particle Invariance Principles And Symmetries

*REFER ALSO TO CITATION(S) 7666*

7692 **(IPNO-TH—86-17) Higher spin fields with mixed symmetry.** Aulakh, C.S.; Koh, I.G.; Ouvry, S. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1986. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750279.

We construct gauge invariant and gauge fixed BRS invariant actions in arbitrary dimensions for free massless integer spin fields carrying mixed representations of the Lorentz group described by Young tableaux. The complete ghost spectrum is deduced by demanding nilpotency of the BRS transformations and leads to a correct count of the on shell degrees of freedom. We use dimensional reduction to study the corresponding gauge invariant massive theory. On shell consistency is then ensured by the fact that the masses arise via a "telescopic Higgs effect".

## 6454 Field Theory

*REFER ALSO TO CITATION(S) 7686, 7687, 7689, 7690*

7693 **(ANL-HEP-CP—86-84) Low p/sub perpendicular/ properties of the Pomeron - theoretical implications in QCD.** White, A.R. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 15p. (CONF-8605163—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001573.

From Workshop on physics simulation at high energies; Madison, WI, USA (5 May 1986).

Experimentally established properties of the Pomeron which cannot be explained within perturbative QCD are reviewed and their theoretical significance elaborated on. The derivation from QCD of a semi-perturbative Pomeron, which has such properties, is described in terms of infra-red divergences of reggeon diagrams and in terms of an infinite momentum winding number condensate due to instanton interactions. The analogy with the known solution of the Schwinger model is emphasized. Asymptotic freedom saturation is needed to justify this picture of the Pomeron and this is satisfied at collider energies if electroweak symmetry breaking is due to color sextet quarks. 24 refs.

7694 **(BNL—38769) Studies of chiral symmetry in a spontaneously broken lattice gauge theory.** Lee, I.H. (Ohio State Univ., Columbus (USA). Dept. of Physics; Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 12p. (CONF-860701—40). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002150.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The phase diagram of lattice SU(2) gauge theory with fundamental representation Higgs fields is probed by l = 1/2 and l = 1 fermions. Quenched calculations of (anti psi psi)/sub l/ show two distinct regions characterized by broken or unbroken chiral symmetry. The location of the boundary between the two regions depends on the representation l of the fermions. For l = 1/2 fermions, we have verified the presence of Nambu-Goldstone bosons ("pions") in the region where chiral symmetry is broken and have found evidence for massless physical fermions in the chirally symmetric region. 6 refs., 5 figs.

7695 **(DOE/ER/10713—7A) Theory of weak interactions and related topics: Progress report, August 1, 1985-August 31, 1986.** Marshak, R.E. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Physics). Sep 1986. Contract AS05-80ER10713. 15p. NTIS, PC A02. File Number DE87002431.

Research highlights are summarized in these areas: preon models of quarks and leptons; supersymmetry and supergravity; and gauge theory of superfluidity. (LEW)

7696 **(DOE/ER/40272—17) Oscillator representation of Witten's three open string vertex function.** Thorn, C.B. (Florida Univ., Gainesville (USA). Dept. of Physics). 1986. Contract FG05-86ER40272. 9p. (CONF-860701—43). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001874.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Using conformal mapping techniques, we show how to calculate the three open string vertex function in Witten's formulation of interacting string field theory. We obtain the vertex for the three strings in arbitrary off shell energy-momentum eigenstates, and we confirm BRS invariance for selected states.

7697 **(LBL—21916) Accelerating the loop expansion.** Ingermanson, R. (Lawrence Berkeley Lab., CA (USA); California Univ., Berkeley (USA). Dept. of Physics). 29 Jul 1986. Contract AC03-76SF00098. 104p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87002569.

This thesis introduces a new non-perturbative technique into quantum field theory. To illustrate the method, I analyze the much-studied phi$^4$ theory in two dimensions. As a prelude, I first show that the Hartree approximation is easy to obtain from the calculation of the one-loop effective potential by a simple modification of the propagator that does not affect the perturbative renormalization procedure. A further modification then suggests itself, which has the same nice property, and which automatically yields a convex effective potential. I then show that both of these modifications extend naturally to higher orders in the derivative expansion of the effective action and to higher orders in the loop-expansion. The net effect is to re-sum the perturbation series for the effective action as a systematic "accelerated" non-perturbative expansion. Each term in the accelerated expansion corresponds to an infinite number of terms in the original series. Each term can be computed explicitly, albeit numerically. Many numerical graphs of the various approximations to the first two terms in the derivative expansion are given. I discuss the reliability of the results and the problem of spontaneous symmetry-breaking, as well as some potential applications to more interesting field theories. 40 refs.

7698 **(LBL—22304) Anomalies in quantum field theory and differential geometry.** Manes, J.L. (Lawrence Berkeley Lab., CA (USA); California Univ., Berkeley (USA). Dept. of Physics). Apr 1986. Contract AC03-76SF00098. 84p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87002545.

Anomalies in field theory appeared first in perturbative computations involving Feynman diagrams. It is only recently that differential geometric techniques have been used to obtain the form of gauge and gravitational anomalies in a direct and simple way. This is possible because of the topological nature of the anomaly. In the first chapter of this thesis the gauged Wess-Zumino action is constructed by differential geometry methods. After reviewing the relevant techniques, an expression for the action valid in any (even) number of space-time dimensions is obtained. This expression is compared with Witten's result in four dimensions. The link between topology and the anomaly is provided by the appropriate index theorem. The index density is a supersymmetric invariant polynomial from which the anomaly and other related objects can be obtained through the use of the "descent equations." A new proof of the Atiyah-Singer index theorem for the Dirac operator is presented. This proof is based on the use of a WKB approximation to evaluate the supertrace of the kernel for a supersymmetric hamiltonian. The necessary WKB techniques are developed and mechanical systems with bosonic and fermionic degrees of freedom are discussed.

7699 **Radiative corrections in the SU(2)/sub L/ X U(1) theory.** Sirlin, A. (Dept. of Physics, New York Univ., New York, NY). pp 521-528 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

The fact that the modern gauge theories of electroweak interactions are renormalizable has stimulated considerable interest in the evaluation of radiative corrections to physical observables. The main objective of this work is the verification of the theory at the level of it quantum corrections. If successful, such an enterprise could become the counterpart of the extraordinary comparisons between theory and experiment carried out in QED since the late forties. There is also a second, more speculative, aim in these studies. It may occur that some of the radiative corrections are sensitive to very short distance phenomena. In that case, accurate comparisons with experiment may give subtle, but significant clues about new physics and exotic phenomena.

7700 **Physics at HERA.** Wolf, G. (Stanford Linear Accelerator Center SLA, Stanford Univ., Stanford, CA). pp 699-724 of Proceedings of the first Aspen Winter physics conference. Block, M.M. New York, NY; The New York Academy of Sciences (1986). (CONF-850146—).

From Aspen winter physics conference; Aspen, CO, USA (14 Jan 1985).

This paper discusses physics at HERA. Structure functions of neutral and charged current reactions can be studied with HERA for Q/sup 2/ values up to 30,000-40,000 GeV/sup 2/. The Q/sup 2/ -v space will be extended by two orders of magnitude in either variable over what can presently be reached. Precise structure function values will provide a stringent test of QCD, will probe for substructure of quarks and leptons down to distances of 3 x 10/sup -18/ cm, and could detect new neutral or charged pieces of the current. In the search for right-handed weak currents, longitudinally polarized electrons will be extremely useful. HERA is potentially a rich source of new particles. Basically any state that has electric and/or weak charge can be produced up to masses of 200-250 GeV. In many aspects, HERA is complementary to LEP. It probes primarily the spacelike region and gives access to charged currents over a unique kinematic range. For a number of the newly proposed particles, the mass range open to HERA experiments exceeds that of LEP II.

7701 **Axial vector current anomaly and the meson decay constants for the improved lattice fermion action.** Hamber, H.W.; Wu, C.M. (Institute for Advanced Study, Princeton, NJ). *Physics Letters [Section] B;* **136B**: No. 4, 255-264(8 Mar 1984). Contract AC02-76ER02220.

The authors discuss the anomaly in the axial vector current for the improved fermion action on the lattice. A detailed discussion of the fermion regularization dependence of the anomaly is given and it is shown that for finite lattice spacing the improved fermion action gives a more reasonable value for the anomaly contribution at finite quark mass than the Wilson action. The authors also present some results on the perturbative corrections to the decay constants of mesons for the improved fermion action. 10 references, 3 figures, 2 tables.

# 65 PHYSICS II

*REFER ALSO TO CITATION(S) 7519*

## 6510 Nuclear Physics

7702 **(CONF-860802—7) Clustering aspects of nuclear structure and reactions.** Betts, R.R.; Rae, W.D.M. (Argonne National Lab., IL (USA); Oxford Univ. (UK). Dept. of Nuclear Physics). 1986. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001529.

From International nuclear physics conference; Harrogate, UK (25 Aug 1986).

Some aspects of clustering phenomena in nuclear structure and reactions are reviewed. Particular emphasis is placed on the relationship between cluster-like states and shape-isomeric states which arise as a result of shell effects in deformed potentials. Some recent evidence in favor of this connection is presented and discussed. 50 refs., 17 figs.

7703 **(DOE/ER/10714—6) Research in nuclear physics: Progress report, April 1, 1986-March 31, 1987.** Mateja, J.F. (Tennessee Technological Univ., Cookeville (USA). Dept. of Physics). Nov 1986. Contract AS05-80ER10714. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002426.

A joint effort by groups from Tennessee Technological University and Florida State University has begun to employ position-sensitive detectors in the study of heavy-ion breakup processes. One aspect of this project currently being pursued is the development of computer software needed to properly manipulate the data and support such experiments. This includes spectra mapping and spectra generation. Additional research concerns formulating a phenomenological model of the formation and evolution of dinuclear molecular complexes in collisions between light nuclei, the creation of a plotting routine for the Rainbow 100 computer, a search for a $1^-$ state in $^{16}O$ at 14.6 MeV, and incomplete fusion processes in $^{28}Si$ induced reactions.

7704 **(DOE/ER/40269—1) Intermediate energy nuclear physics (Task C) and charge exchange reactions (Task W). Technical progress report, October 1, 1985-October 1, 1986.** Kraushaar, J.J. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). Oct 1986. Contract FG02-86ER40269;AC02-81ER40016. 97p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87000830.

This report describes the experimental work in intermediate energy research carried out over the past year at the University of Colorado. The experimental program is very broad in nature, ranging from investigations in pion-nucleus interactions, nucleon charge exchange, inelastic electron scattering, and nucleon transfer reactions. The experiments were largely carried out at the Los Alamos Meson Physics Facility, but important programs were conducted at the Tri-University Meson Facility at the University of British Columbia, the Indiana University Cyclotron Facility and Netherlands Institute for Nuclear Physics Research (NIKHEF-K).

7705 **(PB—86-241494/XAB) Physics through the 1990s: nuclear physics.** (National Research Council, Washington, DC (USA)). 1986. 233p. NTIS, PC A11/MF A01.

See also PB—86-241502; Library of Congress catalog card no. 85-10584.

The volume begins with a non-mathematical introduction to nuclear physics. A description of the major advances in the field follows, with chapters on nuclear structure and dynamics, fundamental forces in the nucleus, and nuclei under extreme conditions of temperature, density, and spin. Impacts of nuclear physics on astrophysics and the scientific and societal benefits of nuclear physics are then discussed. Another section deals with scientific frontiers, describing research into the realm of the quark-gluon plasma; the changing description of nuclear matter, specifically the use of the quark model; and the implications of the standard model and grand unified theories of elementary-particle physics; and finishes with recommendations and priorities for nuclear physics research facilities, instrumentation, accelerators, theory, education, and databases. Appended are a list of national accelerator facilities, a list of reviewers, a bibliography, and a glossary.

## 6511 Experimental Techniques

7706 **(CEA-CONF—8338) Polarized nuclei: beyond the hydrogens.** Glaettli, H. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jan 1986. 8p. (CONF-860126—12). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750264.

From International workshop on polarized sources and targets; Montana, Switzerland (13 Jan 1986).

The nuclei other than the hydrogen isotopes which have been polarized dynamically are compiled in a table, together with some of the relevant information for potential users of polarized nuclei.

## 6512 Nuclear Properties And Reactions, A=1-5, Experimental

7707 **(DOE/ER/03244—124) Weak decay of Λ hypernuclei.** Szymanski, J.J. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)). 1986. Contract AC02-76ER03244. 7p. (CONF-860575—58). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000837.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

The isospin structure of the ΛN → NN non-mesonic weak interaction is discussed as one aspect of hypernuclear weak decay. Measurements of the hypernuclear lifetime and neutron stimulated fraction for /sub Λ/$^{12}$C and /sub Λ/$^{11}$B are reported. Preliminary results for /sub Λ//sup 4,5/He are presented. 15 refs., 6 figs., 3 tabs.

7708 **(DOE/ER/40285—T1) A program in medium-energy nuclear physics: Technical progress report, June-August 1986.** Berman, B.L. (George Washington Univ., Washington, DC (USA)). 1986. Contract FG05-86ER40285. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002428.

Data analysis is proceeding on the following reactions: $^{12}$C(e,e'd), pion scattering on $^{28}$Si and $^{30}$Si, and pion scattering from $^{3}$H and $^{3}$He.

## 6513 Nuclear Properties And Reactions, A=6-19, Experimental

7709 **(LUIP—8514) Alpha particle interactions with nuclei at 12 A GeV/c.** Claesson, G.; Garpman, S.; Lund, I. (Lund Univ. (Sweden). Dept. of Cosmic and Subatomic Physics; Lund Univ. (Sweden). Dept. of Physics). Sep 1985. 10p. (LUNFD6-NFFK—7067-1-9(1985)). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750167.

Pseudo-rapidity density distributions of shower particles from 12 A GeV/c α-emulsion interactions are presented. As compaerd to extrapolations from p-nucleus data, the central α+(Ag,Br) interactions exhibit an excess of particles in the mid pseudo-rapidity region. The correlation between <n> and <nsub(s)>$^{-1}$ are understood within a wounded nucleon model.

## 6514 Nuclear Properties And Reactions, A=20-38, Experimental

7710 **(GANIL-P—86-07) Production of nuclei far from the beta stability line using intermediate-energy heavy ions.** Guerreau, D. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). May 1986. 17p. (CONF-860506—6). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750253.

From International conference on heavy ion nuclear collisions in the Fermi energy domain; Caen, France (12 May 1986).

The production of far unstable nuclei using heavy ion accelerators in the intermediate energy domain is reviewed. The various mechanisms responsible for the production of exotic species, mainly the projectile fragmentation and transfer reactions, are discussed, and the first experimental results presented. Results can be summarized as follows: existence of 4 new isotopes $^{22}$C, $^{23}$N, $^{29}$Ne, $^{30}$Ne; indication of bound character of $^{71}$Ni, $^{72}$Ni; clear evidence for bound character of $^{25}$Si, $^{27}$S, $^{31}$Ar, $^{36}$Ca; indications of bound character of $^{43}$V, $^{46}$Mn, $^{47}$Mn, $^{48}$Fe, $^{50}$Co, $^{52}$Co, $^{52}$Ni, $^{55}$Cu, $^{56}$Cu.

## 6515 Nuclear Properties And Reactions, A=39-58, Experimental

7711 **Systematics of nuclear charge distributions in the region 40≦A≦100 deduced from elastic electron scattering and muonic X-ray measurements.** Wohlfahrt, H.D.; Schwentker, O.; Fricke, G.; Glueckert, S.; Andresen, H.G.; Shera, E.B.; Hoehn, M.V.; Yamazaki, Y.; Steffen, R.M.; Dubler, T.; Kaeser, K. (Universitaet Mainz, West Germany). *Journal of the Physical Society of Japan, Supplement;* **44**: 345-349(1978).

The nuclear charge distribution and nuclear charge distribution differences have been investigated by 300 MeV elastic electron scattering at the Institut fuer kernphysik, Universitaet Mainz. Muonic X-ray measurements yield complementary information to electron scattering results. Both experimental data are analyzed in an almost model independent way. Preliminary data from the 1f/ sub 7/2/ proton and neutron shell, measured at LAMPF and from the Sr-Mo region, measured at S.I.N. shows the same systematic behavior as previous results in the Ni-region. As one result the systematic tendency of differences in nuclear radii between isotones and isotopes seems to be similar: there is a strong shell effect. One observes the differences in radii are largest at the beginning of a neutron or proton shell and decrease linearly to the end of a shell. This tendency of the radii differences of {isotopes/isotones} seems to be quite independent of the {proton/neutron} configuration. Some data of odd-even staggering effects will also be presented. 18 references, 5 figures.

## 6517 Nuclear Properties And Reactions, A=90-149, Experimental

7712 **(CEA-CONF—8450) Semi-exclusive study of $^{84}$Kr (34.5 MeV/u) + $^{93}$Nb.** Charvet, J.L.; Billerey, R.; Chambon, B. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). May 1986. 2p. (CONF-860506—4-Summ.). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750247.

From International conference on heavy ion nuclear collisions in the Fermi energy domain; Caen, France (12 May 1986).

Published in summary form only.

## 6518 Nuclear Properties And Reactions, A=150-189, Experimental

7713 **Ground-state quadrupole moments of /sup 155,157/Gd determined with muonic x-rays.** Tanaka, Y.; Laubacher, D.B.; Steffen, R.M.; Shera, E.B.; Wohlfahrt, H.D.; Hoehn, M.V. (Purdue Univ., West Lafayette, IN). *Physics Letters [Section] B;* **108B**: No. 1, 8-10(7 Jan 1982).

The ground-state quadrupole moments of /sup 155,157/Gd determined by measuring the quadrupole hyperfine-splitting energies of the M X-rays of muonic Gd atoms. The results are Q = 1.30 +/- 0.02 eb for $^{156}$Gd and Q = 1.36 +/- 0.02 eb for $^{157}$Gd. 12 references, 2 figures, 1 table.

## 6519 Nuclear Properties And Reactions, A=190-219, Experimental

7714 **(CEA-CONF—8442) Success of the distorted wave method at very high incident energy.** Barrette, J.; Berthier, B.; Gastebois, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). May 1986. 4p. (CONF-860506—5; CEA-DPH-N-S—2346). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750248.

From International conference on heavy ion nuclear collisions in the Fermi energy domain; Caen, France (12 May 1986).

The one-proton and one-neutron direct surface transfer reactions induced by 793 MeV $^{16}$O incident energy beam bombarding a $^{208}$Pb target nucleus, are widely explained by two selection rules contained in the Dirtorted Wave Method formalism.

7715 **(DOE/ER/04215—T3) Nuclear structure studies at intermediate energies. Annual progress report, October 1985-August 1986.** Hintz, N.M. (Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy). Sep 1986. Contract AC02-77ER04215. 147p. NTIS, PC A07. File Number DE87002269.

New data was collected for proton reactions on lead 208 in the Δ region and the measurement of K/sub ss/ for proton-proton interactions. Analysis of completed experiments concerned determination of scattering amplitudes for proton-proton interactions, the determination of neutron-proton matrix element rations for pion reactions on lead 208, and proton scattering on lead isotopes, nickel isotopes, neodymium 150, gadolinium 154, and osmium 192. Computer program development and theoretical analysis is also reviewed. A list of publications is included. 65 refs., 91 figs., 8 tabs.

## 6520 Nuclear Properties And Reactions, A=220 And Above, Experimental

7716 **(BNL—38665) Neutron multiplicity for neutron induced fission of $^{235}$U, $^{238}$U, and $^{239}$Pu as a function of neutron energy.** Zucker, M.S.; Holden, N.E. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 45p. (IAEA-SM—293-122; CONF-861104—8). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002156.

From International symposium on nuclear material safeguards; Vienna, Austria (10 Nov 1986).

Recent development in the theory and practice of neutron correlation ("coincidence") counting require knowledge of the higher factorial moments of the P/sub $\nu$/ distribution (the probability that ($\nu$) neutrons are emitted in a fission) for the case where the fission is induced by bombarding neutrons of more than thermal energies. In contrast to the situation with spontaneous and thermal neutron induced fission, where with a few exceptions the P/sub $\nu$/ is reasonably well known, in the fast neutron energy region, almost no information is available concerning the multiplicity beyond the average value, [$\nu$], even for the most important nuclides. The reason for this is the difficulty of such experiments, with consequent statistically poor and physically inconsistent results.

7717 **(UCRL—94839) Measurement of the fission cross section of $^{238}$Pu.** Alam, B.; Block, R.C.; Slovacek, R.E.; Hoff, R.W. (Rensselaer Polytechnic Inst., Troy, NY (USA). Gaerttner LINAC Lab.; Knolls Atomic Power Lab., Schenectady, NY (USA); Lawrence Livermore National Lab., CA (USA)). Jul 1986. Contract W-7405-ENG-48. 10p. (CONF-860906—6). NTIS, PC A02/MF A01; GPO Dep. File Number DE86013905.

From Advances in reactor physics and safety meeting; Saratoga Springs, NY, USA (17 Sep 1986).

The fission cross sections of $^{238}$Pu have been measured from 0.1 eV to 80 keV energy range using the Rensselaer Intense Neutron Spectrometer. The cross sections were normalized to the $^{235}$U ENDF/B-V data broadened to the resolution of the Rensselaer Intense Neutron Spectrometer system. The fission areas and widths were determined for the resolved low-energy resonances. The ENDF/B-V fission cross sections for the $^{238}$Pu isotope are, in general, not in good agreement with the measured cross sections and a new evaluation is recommended. The observations of structure in the unresolved fission cross sections is suggestive of the existence of intermediate structure. 18 refs., 1 fig., 1 tab.

7718 **ORELA contribution to thorium cycle nuclear data.** Olsen, D.K. (Oak Ridge National Lab., TN, USA). pp 68-79 of Proceedings of the Japan-U.S. seminar on thorium fuel reactors. Shibata, Toshikazu; Kanda, Keiji; Kobayashi, Katsuhei (eds.) (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). Tokyo, Japan; Atomic Energy Soc. of Japan (1985). (CONF-821082—).

From US-Japan seminar on thorium fuel cycle; Nara, Japan (18 Oct 1982).

Back title: Thorium fuel reactors.

The measurements of direct importance to the $^{232}$Th/$^{233}$U fuel cycle using neutrons from the Oak Ridge Linear Accelerator facility are gathered together and discussed. These measurements were done in response to specific data discrepancies, as part of generic programs, and for basic fission physics studies. In particular, completed transmission and capture work on $^{232}$Th has yielded the most accurate parameters for the first four s-wave resonances; the largest average capture width, 25.2 meV; and the largest s-wave strength function of recent measurements. These results allow improved agreement between differential and integral capture rates. Moreover, the ORNL $^{252}$Cf $\nu$-bar measurement of unprecedented accuracy and $^{233}$U $\nu$-bar ratio measurement give a $^{233}$U prompt $\nu$-bar (thermal) of 2.490 +- 0.009 neutron/fission. This result allows a much more satisfactory understanding of the $^{233}$U 2200 m/s constants. In addition, a $^{232}$Th $\gamma$-ray production measurement provides needed cross sections for shielding, and important data for both application and fission physics were obtained from $^{232}$Th fission and both $^{231}$Pa and $^{234}$U fission and total cross section measurements. Data requirements and discrepancies suggested from this work are discussed.

## 6530 Nuclear Theory

*REFER ALSO TO CITATION(S) 7715*

7719 **(ANL-HEP-CP—86-103) EMC effect.** Berger, E.L. (Argonne National Lab., IL (USA)). Sep 1986. Contract W-31-109-ENG-38. 30p. (CONF-860701—35). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001551.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

A review is presented of data and theoretical interpretations of the nuclear dependence of quark and antiquark distributions as observed in the deep inelastic scattering of neutrinos and charged leptons from nuclei. After a summary of the experimental situation and a survey of proposed explanations, the author concentrates on interpretations in terms of conventional nuclear physics and on the $Q^2$-rescaling approach. The review concludes with a list of desirable future experiments. 32 refs., 5 figs.

7720 **(CEA-CONF—8282) Heavy ion collisions at high energy: experimental approach.** Babinet, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Sep 1985. 91p. (In French). (CONF-8509303—3; DPH-N-S—2308). NTIS (US Sales Only), PC A05/MF A01. File Number DE87750249.

From Jolio-Curie school on nuclear matter in all its states; Bombannes, France (16 Sep 1985).

These talks on experimental aspects of relativistic heavy ion collisions have been divided in three different subjects. First we start with an overview of present inclusive data. The essential features have been stressed out and are discussed in terms of simple phenomenological models. We then proceed to discuss two-particle correlation measurements. Large angle correlations are connected to the role of single nucleon-nucleon scattering in nucleus-nucleus collisions. Correlations at small relative impulse, a kind of interferometry measurement, are related to the size and the lifetime of the source that emits particles. Pion and proton measurements with their respective aspects are discussed separately. Some results on the production of unstable light nuclei and their connections to correlation measurements are also presented. The last subject deals with exclusive experiments that started with the new $4\pi$ electronic detectors. Global variable analysis and the measurement of a collective flow in heavy ion collisions are discussed in details. Finally we conclude with some indications of a new method, the so-called transverse momentum analysis. It should allow an experimental measurement of an essential quantity, the full triple differential cross section unaveraged over the reaction plane azimuthal angle.

7721 **(CEA-CONF—8384) Review of heavy ion reaction mechanisms.** Ngo, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Apr 1986. 22p. (CONF-8604184—4; CEA-DPH-N-S—2333). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750250.

From Symposium on 10 years of uranium beam; Darmstadt, F.R. Germany (2 Apr 1986).

We review some of the many aspects of heavy-ion reaction mechanisms observed at bombarding energies smaller than approximately 50 MeV/u that is to say in what is called the low bombarding energy domain and the intermediate bombarding energy domain. We emphasize the results concerning the use of very heavy projectiles which has led to the observation of new mechanisms.

7722 **(CEA-CONF—8441) Incomplete transfer of linear momentum and excitation energy between 20 and 80 MeV/u.** Leray, S. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). May 1986. 14p. (CONF-860506—3; CEA-DPH-N-S—2340). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750246.

From International conference on heavy ion nuclear collisions in the Fermi energy domain; Caen, France (12 May 1986).

Recent results concerning intermediate energy heavy ion central collisions are reviewed. It appears that the amount of the initial linear momentum that can be transferred to the composite system regularly decreases with increasing bombarding energy. There seems to be a limiting value near 175 MeV/c for the transferred linear momentum per nucleon. With $^{40}$Ar projectile above about 35 MeV/u, the maximum energy per nucleon that a system can contain seems to have been reached, making quasi fusion process progressively vanishing.

7723 **(GANIL-P—85-15) Heavy-ion physics in the intermediate energy domain.** Doubre, H. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750252.

Experimental results from GANIL are reviewed with special emphasis on data about the transitional behaviour of nuclear matter around 30 MeV/nucleon, and about the limits of excitation a nucleus can sustain.

7724 **(GSI—86-20-Prepr.) Correlation effects on the level density of a hot nucleus.** Hasse, R.W.; Schuck, P. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Jul 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750080.

We generalize our previously introduced model for correlation effects on the level density parameter, a, to finite temperatures. We find that the increase of a due to the correlations at zero temperature vanishes within a certain range around Tapprox.=4 MeV, in agreement with recent experimental studies.

7725 **(IPNO-TH—86-8) Sum rule approach to total muon capture rates.** Navarro, J.; Krivine, H. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Feb 1986. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750288.

The total muon capture rate is expanded in terms of sum rules and the convergence of such an expansion is analysed. It results that the energy-weighted and the inverse-energy-weighted sum rules provide an accurate estimate for the total rate in agreement with a complete RPA calculation through the response function. The static polarizability of the isovector dipole mode turns out to be the relevant quantity to determine the total muon capture rate, in light and medium nuclei.

7726 **(N—86-28721) Transport model of nucleon-nucleus reaction.** Wilson, J.W.; Townsend, L.W.; Cucinott, F.A. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Jul 1986. 17p. (NASA-TM—87724; NAS—1.15:87724). NTIS, PC A02/MF A01.

A simplified model of nucleon-nucleus reaction is developed and some of its properties are examined. Comparisons with proton production measured for targets of Al-27, Ni-58, Zr-90, and Bi-209 show some hope for developing an accurate model for these complex reactions. It is suggested that binding effects are the next step required for further development.

7727 **(N—86-30485) Cross section calculations for subthreshold pion production in peripheral heavy-ion collisions.** Norbury, J.W.; Cucinotta, F.A.; Deutchman, P.A.; Townsend, L.W. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Aug 1986. 27p. (NASA-TP—2600; L—16129; NAS—1.60:2600). NTIS, PC A03/MF A01.

Total cross sections, angular distributions, and spectral distributions for the exclusive production of charged and neutral subthreshold pions produced in peripheral nucleus-nucleus collisions are calculated by using a particle-hole formalism. The pions result from the formation and decay of an isobar giant resonance state formed in a C-12 nucleus. From considerations of angular momentum conservation and for the sake of providing a unique experimental signature, the other nucleus, chosen for this work to be C-12 also, is assumed to be excited to one of its isovector (1+) giant resonance states. The effects of nucleon recoil by the pion emission are included, and Pauli blocking and pion absorption effects are studied by varying the isobar width. Detailed comparisons with experimental subthreshold pion data for incident energies between 35 and 86 MeV/nucleon are made.

7728 **(UCRL—15847-Vol.2) Calculated fission properties of the heaviest elements: Vol. 2, Calculated single-particle levels in heavy nuclei.** Moeller, P.; Nix, J.R.; Swiatecki, W. (Lawrence Livermore National Lab., CA (USA); Los Alamos National Lab., NM (USA)). Sep 1986. Contract W-7405-ENG-48. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002500.

The decay properties of nuclei in many cases depend strongly on the quantum numbers of the single-particle levels in the vicinity of the Fermi surface. A striking illustration is the prolonged fission half-lives of odd nuclei relative to their even neighbors. The hindrance factor depends on the spin of unpaired odd particle and increases with increasing spin of the odd particle. The effect has been studied theoretically. For $^{257}$Fm the hindrance factor is almost ten orders of magnitude. The computer code for calculating nuclear masses calculates single-particle levels at the deformations considered as one step in the calculations. This code has been run for all nuclei considered in the 1981 mass study and the calculated single-particle levels were stored on permanent mass storage. This is actually point (I.D.1) in the research plan ('UNIFIED MODEL ...'). A computer code has been constructed for extracting levels of nuclei that are specified to the program and plotting them. Four such plots are included in this report as figs. 1-4. The levels are plotted relative to the Fermi surface of each nucleus. It is clear from the pictures that for $^{257}$Fm the calculations predict the N = 157 neutron orbital to have spin 9/2+ as is also found experimentally. The high spin is the reason for the large hindrance factor for fission of $^{257}$Fm. Figures of the type included here may be used to quickly survey larger regions of nuclei for candidates for special properties, such as unusually large hindrance factors in fission. More detailed calculations are usually required to determine the magnitude of the effects. We also include tables of the plotted single-particle levels since it is not always possible to determine the spin from an inspection of the plots, when levels are overlapping. 4 figs.

7729 **(UCRL—15847-Vol.3) Calculated single-proton levels for nuclei with N equal to 152, 154, 156, 158, 160 and 162.** Moeller, P.; Nix, J.R.; Swiatecki, W. (Lawrence Livermore National Lab., CA (USA); Los Alamos National Lab., NM (USA)). Sep 1986. Contract W-7405-ENG-48. 33p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002501.

The decay properties of nuclei in many cases depend strongly on the quantum numbers of the single-particle levels in the vicinity of the Fermi surface. A striking illustration is the prolonged fission half-lives of odd nuclei relative to their even neighbors. The hindrance factor depends on the spin of unpaired odd particle and increases with increasing spin of the odd particle. The effect has been studied theoretically. For $^{257}$Fm the hindrance factor is almost ten orders of magnitude. The computer code for calculating nuclear masses calculates single-particle levels at the deformations considered as one step in the calculations. We have run this code at the ground state deformation of all nuclei considered in the 1981 mass

study and stored the calculated single-particle levels on permanent mass storage. A computer code has been constructed for extracting levels of nuclei that are specified to the program and plotting them. In this report we consider single-proton levels for even-N nuclei in the range $152 \leqq N \leqq 162$. Six such plots are included in this report. The levels are plotted relative to the Fermi surface of each nucleus. We also include tables of the plotted single-particle levels since it is not always possible to determine the spin from an inspection of the plots, when levels are overlapping. 6 figs.

## 6540 Radiation And Shielding Physics

**7730 (IKE—6-168) Coupled procedure of integral Psub(L) and differential Ssub(N) approximation of the transport equation for the solution of streaming problems for big cavities.** Neumann, K. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Mar 1986. 144p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87750075.

The transport equation is solved by means of the Psub(L)-approximation in the cavities and Ssub(N)-approximation in the surrounding materials. The coupling of these approximations is achieved by general boundary conditions of Psub(L)-approximation. Separate Legendre expansions in four directional quadrants take care of strong directional streaming through cavities. To solve the Psub(L)-approximation for particle transport a modular program has been developed. The coupling of this program with a well proved Ssub(N)-code leads to a user friendly program system. The results of the new method have been compared with exact solutions of different problems found in literature and for certain self-defined problems derived from streaming calculations through the top reflector of a high temperature reactor. It is shown, that for big cavities with great flux gradients along the boundaries the results of the coupled method are much better than those of Ssub(N)-calculations.

**7731 (LUIP—8409) Search for anomalous fragments in 1.8 A GeV $^{40}$Ar reactions in nuclear emulsions.** Claesson, G.; Garpman, S.; Herrstroem, N.Y. (Lund Univ. (Sweden). Dept. of Cosmic and Subatomic Physics; Svenska Atomfoersaekringspoolen, Stockholm). Sep 1984. 14p. (LUNFD6-NFFK—7047-1-9(1984)). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750161.

Results are presented from an investigation of the mean free path in nuclear emulsion of multiply charged fragments, produced by 1.8 A GeV Argon nuclei. Charge identification of 6965 fragments with charges Z > or equal to 2, producing 2192 secondary interactions has been made. No dependence of the mean free path on the distance from the preceding collision is observed and thus our result is consistent with the non-existence of anomalons.

## 6550 Medical Physics

*REFER ALSO TO CITATION(S) 7366, 7422, 7425*

**7732 (ORNL/RSIC—48) Approximate calculational techniques for radiation protection applications (collection of papers presented at the November 1985 American Nuclear Society meeting).** Rice, A.F.; Roussin, R.W. (comps.). (Oak Ridge National Lab., TN (USA)). Sep 1986. Contract AC05-84OR21400. 156p. (ANS/SD—86/17). NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87002165.

Although radiation protection principles are, on the whole, well understood and a whole series of computer codes exist for their solution, it is felt that there is a need for practical, approximate techniques to be used by the practicing nuclear engineer for a variety of applications. Within the context of approximate techniques, the papers presented cover a broad overview of specific problems, for example, skyshine and penetration analysis, with applications extending from general nuclear reactor design to spent fuel storage and fusion. Separate abstracts have been prepared for individual papers.

**7733 (PTB-ND—27) Experimental facilities for calibrations at the dosimetry facility of group 6.5 'Neutron dosimetry' at the Physikalisch-Technische Bundesanstalt.** Strzelczyk, H. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Neutronendosimetrie). Jul 1986. 24p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750082.

The mechanical and electrical layout of the "Dosimetriemessplatz", a low scattering target area at the accelerator facility is described. Monoenergetic neutrons are generated at the irradiation facility for the research on neutron detectors and dosimeters for radiation protection. The report is aimed to inform dosimetry in particular for those guest's coming from other laboratories. For that purpose a detailed description is given of the mechanical construction, of cable connections and of the monitor system. The feasibitity of data transfer from the system at the target position to the user's system and the mode of acceptance of external data are explained.

## 6560 Condensed Matter Physics

**7734 (BNL—38821) Critical magnetic scattering from the Heisenberg ferromagnet EuS.** Boeni, P.; Shirane, G.; Bohn, H.G.; Zinn, W. (Brookhaven National Lab., Upton, NY (USA); Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). 1986. Contract AC02-76CH00016. 26p. (CONF-861111—13). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002141.

From Conference on magnetism and magnetic materials; Baltimore, MD, USA (17 Nov 1986).

The paramagnetic scattering from the insulating, isotropic ferromagnet EuS is investigated at T/sub c/ along the [111] direction by means of inelastic neutron scattering. The energy width of the quasielastic scattering is proportional to q/sup z/ with $z = 2.54 +- 0.10$, in good agreement with the predictions of dynamical scaling theory ($z = 2.5$). z is, however, significantly larger than the value deduced from measurements along the [100] direction ($z = 2.2$). Near the zone boundary the magnetic scattering exhibits shoulders the shapes of which deviate from theoretical predictions based on the Heisenberg model. 19 refs., 3 figs.

**7735 (CONF-861111—10) Soliton spin configurations along the classical anisotropic Heisenberg chain.** Gaulin, B.D. (Oak Ridge National Lab., TN (USA); McMaster Univ., Hamilton, Ontario (Canada). Dept. of Physics). 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001684.

From Conference on magnetism and magnetic materials; Baltimore, MD, USA (17 Nov 1986).

The spin configurations of a one-dimensional, weakly anisotropic Heisenberg antiferromagnet were examined by means of an importance sampling Monte Carlo simulation. The spin interactions display weak anisotropies of the same form in each of the orthogonal XY and XZ planes. This allows for two soliton modes, with one in each of the planes. The soliton density within the XZ plane has been determined as a function of the relative strengths of the two anisotropies as well as of temperature. These results are compared with theoretical analysis of similar systems.

**7736 (CONF-8610159—1) Multipolar excitations in small metallic spheres.** Claro, F.; Fuchs, R. (Oak Ridge National Lab., TN (USA); Ames Lab., IA (USA)). Oct 1986. Contract W-7405-ENG-82;AC05-84OR21400. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002170.

From International symposium on the physics and chemistry of small clusters; Richmond, VA, USA (28 Oct 1986).

A dielectric function $E(\omega,l)$ appropriate to a small metallic sphere is obtained within the semiclassical infinite barrier model, where l is the multipole order. An excitation diagram in the $l,\omega$ plane based on the structure of this function is proposed. It represents the spherical analog of the excitation structure of an infinite medium in the $k,\omega$ plane. 8 refs., 1 fig.

7737 **(DOE/ER/45246—1) Study of the Embedded Atom Method of atomistic calculations for metals and alloys: Progress report, March 1, 1986-February 28, 1987.** Johnson, R.A. (Virginia Univ., Charlottesville (USA). School of Engineering and Applied Science). Nov 1986. Contract FG05-86ER45246. 11p. (UVA—527340/MS87/101). NTIS, PC A02/MF A01; GPO Dep. File Number DE87002436.

The relationships between the physical input and output of the Embedded Atom Method (EAM) used in atomistic calculations for metals and alloys and the model functions and parameters are being investigated. An analytic fcc EAM model has been derived based on short-ranged approximations to the input functions in EAM. This model then permits an analytic study of the parameter dependence of physical properties given by EAM. The most surprising result to date is that the vacancy formation energy is strongly dependent on the shear modulus, shows a much smaller dependence on the bulk modulus, and is almost independent of the cohensive energy. 3 refs.

7738 **(N—86-28776) Temperature effects on the universal equation of state of solids.** Vinet, P.; Ferrante, J.; Smith, J.R.; Rose, J.H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Apr 1986. 29p. (NASA-TM—87321; E—3001; NAS—1.15:87321). NTIS, PC A03/MF A01.

Recently it has been argued based on theoretical calculations and experimental data that there is a universal form for the equation of state of solids. This observation was restricted to the range of temperatures and pressures such that there are no phase transitions. The use of this universal relation to estimate pressure-volume relations (i.e., isotherms) required three input parameters at each fixed temperature. It is shown that for many solids the input data needed to predict high temperature thermodynamical properties can be dramatically reduced. In particular, only four numbers are needed: (1) the zero pressure (P=0) isothermal bulk modulus; (2)it P=0 pressure derivative; (3) the P=0 volume; and (4) the P=0 thermal expansion; all evaluated at a single (reference) temperature. Explicit predictions are made for the high temperature isotherms, the thermal expansion as a function of temperature, and the temperature variation of the isothermal bulk modulus and its pressure derivative. These predictions are tested using experimental data for three representative solids: gold, sodium chloride, and xenon. Good agreement between theory and experiment is found.

7739 **(PB—86-241478/XAB) Physics through the 1990s: condensed-matter physics.** (National Research Council, Washington, DC (USA)). 1986. 323p. NTIS, PC A14/MF A01.

See also PB—86-241510; Library of Congress catalog card no. 85-21778.

The volume presents the current status of condensed-matter physics from developments since the 1970s to opportunities in the 1990s. Topics include electronic structure, vibrational properties, critical phenomena and phase transitions, magnetism, semiconductors, defects and diffusion, surfaces and interfaces, low-temperature physics, liquid-state physics, polymers, nonlinear dynamics, instabilities, and chaos. Appendices cover the connections between condensed-matter physics and applications of national interest, new experimental techniques and materials, laser spectroscopy, and national facilities for condensed-matter physics research. The needs of the research community regarding support for individual researchers and for national facilities are presented, as are recommendations for improved government-academic-industrial relations.

7740 **(N—86-28709) Role of spinning electrons in paramagnetic phenomena.** Bose, D.M. Translated from *Zeitschrift fuer Physik ;* **43**: No. 8, 864-882(1927). 27p. (NASA-TM—88439; NAS—1.15:88439). NTIS, PC A02/MF A01.

An attempt is made to explain paramagnetic phenomena without assuming the orientation of a molecule or ion in a magnetic field. Only the spin angular momentum is assumed to be responsible. A derivative of the Gurie-Langevin law and the magnetic moments of ions are given as a function of the number of electrons in an inner, incomplete shell. An explanation of Gerlach's experiments with iron and nickel vapors is attempted. An explanation of magnetomechanical experiments with ferromagnetic elements is given.

## 6561 Superconductivity

*REFER ALSO TO CITATION(S) 6818, 6973*

## 6570 Theoretical And Mathematical Physics

*REFER ALSO TO CITATION(S) 7073, 7078, 7209, 7518, 7629, 7852, 7857, 7859, 7860*

7741 **(CEA-CONF—8236) Oscillating Maxwellians: exact solutions for the Boltzmann equation.** Cornille, H. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jun 1985. 19p. (CONF-8506315—1; SPhT—85-116). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750257.

From 2. international workshop MAFPD; Orsay, France (24 Jun 1985).

For two classes of non linear Boltzmann equations, when the particles are of the Maxwell type and external forces are present, we present explicit distributions solutions. First, for the homogeneous one dimensional Kac model, for which momentum conservation has been dropped, we include linear velocity forces and uniform source terms. Second, for the homogeneous and inhomogeneous Boltzmann equations of dimension $d > 1$, for which both energy and momentum conservations hold, we include either spatially dependent forces or velocity forces plus uniform sources. For both classes there exist examples of distributions which relax towards oscillating Maxwellians and other towards absolute Maxwellians. We give the complete proofs for the Kac model and present results for the $d > 1$ dimensional models.

7742 **(CNRS-CPT—85-P-1817) Stability and chaotic behaviour of quantum rotators.** Bellissard, J. (Centre National de la Recherche Scientifique, 13 - Marseille (France). Centre de Physique Theorique). Oct 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750277.

This report deals with: 1) introduction and models, 2) Floquet's theory, 3) time behavior and quasi energy spectrum, 4) quantum rotators: rigorous results, 5) chaotic behavior: numerical results.

7743 **(PB—86-241486/XAB) Physics through the 1990s: gravitation, cosmology, and cosmic-ray physics.** (National Research Council, Washington, DC (USA)). 1986. 186p. NTIS, PC A09/MF A01.

See also PB—86-241536; Library of Congress catalog card no. 85-32019.

The volume contains recommendations for space- and ground-based programs in gravitational physics, cosmology, and cosmic-ray physics. The section on gravitation examines current and planned experimental tests of general relativity; the theory behind, and search for, gravitational waves, including sensitive laser-interferometric tests and other observations; and advances in gravitation theory (for example, incorporating quantum effects). The section on cosmology deals with the big-bang model, the standard model from elementary-particle theory, the inflationary model of the Universe. Computational needs are presented for both gravitation and cosmology. Finally, cosmic-ray physics theory (nucleosynthesis, acceleration models, high-energy physics) and experiment (ground and spaceborne detectors) are discussed.

7744 **Galaxies and planetary rings: gravitational analogues of nonneutral plasmas.** Mark, J.W-K. (Lawrence Livermore National Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 25-35(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

Orbit and collective dynamics in disk galaxies and in Saturn's rings are gravitational analogues of those occurring in nonneutral plasmas. Interesting problems for such 'gravitational plasmas' include 2D spiral density waves in these disks which are responsible for observable spiral-structure. These waves are analogous to electrostatic waves in nonneutral beam plasmas, particularly

analogous to single-disk studies of transverse waves in particle beams. Disk galaxies and planetary rings also exhibit 3D bending waves with motions which distort (or bend) flat disks perpendicular to their original flat plane but whose propagation vector is largely restricted to directions in the original disk. Various orbit-wave resonance phenomena are frequently of importance in both spiral density and bending waves.

7745 **Chiral-symmetry-breaking states and their sensitivity in nonequilibrium chemical systems.** Kondepudi, D.K.; Nelson, G.W. (Univ. of Texas, Austin). *Physica A (Amsterdam);* **890A**: vp(1984). Contract AS05-81ER10947.

Symmetry (nonequilibrium) breaking and sensitivity are discussed in the context of the chemical of chiral molecules. It is shown that systems that break chiral symmetry are so sensitive to small chiral interaction that an interaction energy E/sub int/ > $10^{-18}$ - $10^{-17}$ kT is sufficient to have strong chiral selectivity. Such energies are within the range of parity violating weak-neutral-current interactions. Chiral interaction energies due to a combination of electric, magnetic, gravitational and centrifugal fields, even when high field strengths are considered, are found to be less than $10^{-19}$ kT. Plausible chemical systems that involve rhodium catalysts in which weak-neutral-current energies should be high are also briefly discussed. 24 references, 1 figure.

# 70 FUSION ENERGY

## 7001 Plasma Research

*REFER ALSO TO CITATION(S) 7001, 7647, 7649, 7812, 7813, 7814, 7827, 7828*

7746 **(DOE/ER/53216—1) Wisconsin Torsatron/Stellarator Program, FY 1987.** (Wisconsin Univ., Madison (USA)). 1986. Contract FG02-86ER53216. 222p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87002120.

The research of the Torsatron/Stellarator Laboratory during the present contract period has concentrated on several main areas. The confinement in IMS is being investigated under the conditions of an applied vertical magnetic field and with the insertion of a localized limiter. Excellent agreement between a simplified stochastic heating theory and the measured electron cyclotron breakdown and heating phases of the Proto-Cleo torsatron have been achieved. Measurements of the secondary currents and the ability to drive currents using Alfven waves are continuing on the Proto-Cleo stellarator. Theoretical efforts have concentrated on modelling the experimental devices, including 1-D transport modelling, particle-in-cell simulation and divertor field line following codes.

7747 **(DOE/ET/51013—192) Absolute sensitivity calibration from 20 A to 430 A of a grazing incidence spectrometer with a multi-element spectral detector.** Terry, J.L.; Manning, H.L.; Marmar, E.S. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Jul 1986. Contract AC02-78ET51013. 20p. (PFC/CP—86-11; CONF-860880—32). NTIS, PC A02/MF A01; GPO Dep. File Number DE87000628.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

Two methods which together allow sensitivity calibration from 20 A to 430 A are described in detail. The first method, useful up to 120 A, uses a low power source to generate Kα x-rays which are alternately viewed by an absolute detector (a proportional counter) and the spectrometer. The second method extends that calibration to 430 A. It relies on the 2:1 brightness ratio of bright doublet lines from impurity ions which have a single outer shell electron and which are present in hot, magnetically confined plasmas. It requires that the absolute sensitivity of the spectrometer be known at one wavelength point, and in practice requires a multi-element spectral detector.

7748 **(DOE/ET/53088—235) Theory of hot particle stability.** Berk, H.L.; Wong, H.V.; Tsang, K.T. (Texas Univ., Austin (USA). Inst. for Fusion Studies; Science Applications International Corp., Boulder, CO (USA)). Oct 1986. Contract FG05-80ET53088. 37p. (IFSR—235). NTIS, PC A03/MF A01; GPO Dep. File Number DE87001933.

The investigation of stabilization of hot particle drift reversed systems to low frequency modes has been extended to arbitrary hot beta, $\beta$/sub H/ for systems that have unfavorable field line curvature. We consider steep profile equilibria where the thickness of the pressure drop, $\Delta$, is less than plasma radius, r/sub p/. The analysis describes layer modes which have m$\Delta$/r/sub p/ < 1, where m is the mode number, and radial structure larger than $\Delta$. We show that in making a continuous transition from the fragile stability regime to the robust stability regime one must go through an unstable region. To bridge the unstable band in a physical manner one must either produce robust stability conditions very rapidly, or use transient stability techniques such as ponderomotive forces or transient minimum-B coils. We explicitly exhibit the positive energy stabilization terms of the layer mode from wall stabilization terms and finite Larmor radius terms. It is shown the robust stability can even be achieved with only wall stabilization, for all possible m-values of the layer modes if $\beta$/sub H/ > 2/3. When robust stability conditions are fulfilled, the hot particles will have their axial bounce frequency less than their grad-B drift frequency. This allows for a low bounce frequency expansion to describe the axial dependence of the magnetic compressional response.

7749 (DOE/ET/53088—252, pp 1-4) **Turbulent drift-wave dynamics and coherent structures.** Scott, B.D.; Terry, P.W.; Diamond, P.H. (Univ. of Texas, Austin). Sep 1986. NTIS, PC A03/MF A01. File Number DE87002036. (IFSR—252).

In Papers presented by IFS (Institute for Fusion Studies)/ FRC (Fusion Research Center) members at the international workshop on small scale turbulence and anomalous transport in magnetized plasmas.

The dynamics of decaying 2D drift-wave turbulence are investigated numerically in the absence of assumptions in the relation between the electrostatic potential and the density response, with the result that nonlinear coupling dominates this in the hydrodynamic region about the resonant surface. Outside this region, an adiabatic relation prevails. Thus, the nonadiabatic density response is small away from the resonant surface but can be as large as the potential fluctuation near it. This response is much more self-coherent than either the density or potential fluctuations and decays more slowly as well, becoming dominant.

7750 (DOE/ET/53088—252, pp 5-19) **Fluctuations and transport measurements in the TEXT Tokamak.** Bengtson, R.D.; Bravenec, R.V.; Brower, D.L.; Diamond, P.H.; Gentle, K.W.; Klepper, C.C.; Luhmann, N.C. Jr.; Peebles, W.A.; Phillips, P.E.; Powers, E.J.;. (Univ. of Texas, Austin; Univ. of California, Los Angeles). Sep 1986. NTIS, PC A03/MF A01. File Number DE87002036. (IFSR—252).

In Papers presented by IFS (Institute for Fusion Studies)/ FRC (Fusion Research Center) members at the international workshop on small scale turbulence and anomalous transport in magnetized plasmas.

We present measurements of density and potential fluctuations under typical discharge conditions in the TEXT tokamak using Langmuir probe and far-infrared Thomson scattering techniques. A direct measurement of the fluctuation induced particle flux is presented and compared with global particle confinement measurements. Measurements of poloidal asymmetry and their effects on transport are discussed.

7751 **(IAEA-CN—47/D-I-4) Transport theory in stellarators.** Shaing, K.C.; Hirshman, S.P.; Beasley, C.O. Jr.; Crume, E.C. Jr.; Van Rij, W.I. (Oak Ridge National Lab., TN (USA); Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)). 1986. Contract AC05-84OR21400. 7p. (CONF-861106—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000884.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

Stellarator transport is studied numerically by solving the linearized drift kinetic equation for realistic toroidal magnetic geometries. In the plateau regime, a resonant enhancement factor for diffusion that agrees with analytic results is found. In the lower collisionality regimes, the structure of the particle distribution function in phase space is computed to examine the validity of approximate boundary conditions empolyed in analytic calculations. A diffusion coefficient D in the collisionless detrapping regime is computed. The effect on diffusion of a resonance between parallel and E x B motions is studied. Diffusion coefficients for a $\sigma$-optimized configuration are calculated and shown to compared favorably with those obtained from a Monte Carlo code.

7752 **(IAEA-CN—47/D-III-1) Plasma heating in stellarator/torsatrons and tokamaks by ion cyclotron waves.** Jaeger, E.F.; Batchelor, D.B.; Imre, K.; Weitzner, H. (Oak Ridge National Lab., TN (USA); New York Univ., NY (USA). Courant Inst. of Mathematical Sciences). 1986. Contract FG02-86ER53223;AC05-84OR21400. 14p. (CONF-861106—9). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001832.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

High power ion cyclotron heating experiments are currently planned for the Heliotron-E device in Kyoto and for the ATF torsatron at Oak Ridge. Reliable solutions for the rf fields and wave absorption are needed to optimize antenna designs and heating scenarios as well as to determine heating profiles and tail formation for interpretation of confinement experiments. The complicated field structure in torsatrons makes a number of approximations commonly used in studying ICRH in tokamaks of questionable validity. For example in tokamaks the cyclotron resonance and ion-ion hybrid resonance layers are to a good approximation vertical sections and small changes of frequency or B field result in small shifts in their locations. However, in a torsatron a saddle point in B occurs near the magnetic axis so that resonance and cutoff layers occur on two sheets oriented either horizontally or vertically. Small changes of frequency therefore can cause radical changes in the resonance cutoff topology. We have investigated this phenomenon by performing 2-D calculations of the wave fields and heating profiles in a cold plasma model. We have also begun to investigate the effects of finite temperature in this geometry by calculating cyclotron damping/mode conversion in a slab having non-monotonic B profile. Resonances and cutoffs therefore exist in pairs and by adjusting the wave frequency can be made to merge together and annihilate in pairs.

7753 **(IPP—4/227) Comments on the Alfven wave spectrum as measured on the TCA tokamak.** Puri, S. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.); Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Jun 1986. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87750085.

The heating in the TCA tokamak is ascribed to a combination of compressional Alfven wave heating (CAW) and discrete Alfven wave (DAW) heating. In this communication we invoke an alternative plasma heating mechanism by the direct excitation of torsional Alfven waves (TAW) to account for the observed features of the TCA experiment.

7754 (N—86-31409, pp vp) **Laser techniques for arc jet plasma diagnostics; continuation of a feasibility and design study.** Wierum, F.A. Jul 1986. NTIS, PC A99/MF E03. (NASA-CR—171931; NAS—1.26:171931).

In NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1985.

This study is concerned with the continuation of a feasibility and design study of laser-based diagnostic techniques for the non-instrusive measurement of species concentrations, temperatures, and velocity in the low density, high enthalpy flow through the arc-heated wind tunnel facility (ARMSEF) at NASA/JSC. Last summer several laser-induced radiation scattering methods were investigated and some preliminary measurements of the spectral distribution of radiation emitted by the arc-heated gas flow were made. Based upon those preliminary measurements and subsequent investigations, four laser-induced radiation scattering methods were selected for further detailed study, and preliminary design of a measurement system has been undertaken. Further measurements of the spectral distribution of radiation emitted from the arc-heated free stream and shock layer flows, using a redesigned measurement system, have been made for one axial position in the flow for a range of tunnel operating power levels. Further study of the literature for physical property data, theoretical models of processes, and applications of the diagnostic methods has been also carried out.

7755 **(PPPL—2266) Propagation of a nonrelativistic electron beam in a plasma in a magnetic field.** Okuda, H.; Horton, R.; Ono, M.; Ashour-Abdalla, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.; California Univ., Los Angeles (USA)). Oct 1986. Contract AC02-76CH03073. 45p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002366.

Propagation of a nonrelativistic electron beam in a plasma in a strong magnetic field has been studied using electrostatic one-dimensional particle simulation models. Electron beams of finite pulse length and of continuous injection are followed in time to study the effects of beam-plasma interaction on the beam propagation. For the case of pulsed beam propagation, it is found that the beam distribution rapidly spreads in velocity space generating a plateaulike distribution with a high energy tail extending beyond the initial beam velocity.

7756 **(UCRL—53764) Intense microwave pulse propagation through gas breakdown plasmas in a waveguide.** Byrne, D.P. (Lawrence Livermore National Lab., CA (USA)). 8 Oct 1986. Contract W-7405-ENG-48. 172p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87002752.

High-power microwave pulse-compression techniques are used to generate 2.856 GHz pulses which are propagated in a $TE_{10}$ mode through a gas filled section of waveguide, where the pulses interact with self-generated gas-breakdown plasmas. Pulse envelopes transmitted through the plasmas, with duration varying from 2 ns to greater than 1 $\mu$s, and peak powers of a few kW to nearly 100 MW, are measured as a function of incident pulse and gas pressure for air, nitrogen, and helium. In addition, the spatial and temporal development of the optical radiation emitted by the breakdown plasmas are measured. For transmitted pulse durations $\geq$ 100 ns, good agreement is found with both theory and existing measurements. For transmitted pulse duration as short as 2 ns (less than 10 rf cycles), a two-dimensional model is used in which the electrons in the plasma are treated as a fluid whose interactions with the microwave pulse are governed by a self-consistent set of fluid equations and Maxwell's equations for the electromagnetic field. The predictions of this model for air are compared with the experimental results over a pressure range of 0.8 torr to 300 torr. Good agreement is obtained above about 1 torr pressure, demonstrating that microwave pulse propagation above the breakdown threshold can be accurately modeled on this time scale. 63 refs., 44 figs., 2 tabs.

7757 **(UCRL—95567) TMX-U Tandem-Mirror thermal-barrier experiments.** Simonen, T.C.; Allen, S.L.; Baldwin, D.E.; Barter, J.D.; Berzins, L.V.; Carter, M.R.; Casper, T.A.; Clauser, J.F.; Coensgen, F.H.; Correll, D.L. (Lawrence Livermore National Lab., CA (USA); TRW, Inc., Redondo Beach, CA (USA); California Univ., Davis (USA); Sandia National Labs., Livermore, CA (USA); Maryland Univ., College Park (USA); Japan Atomic Energy Research Inst., Tokai, Ibaraki). 29 Oct 1986. Contract W-7405-ENG-48. 15p. (IAEA-CN—47/C-I-1; CONF-861106—11). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002162.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

Thermal-barrier experiments have been carried out in the Tandem Mirror Experiment-Upgrade (TMX-U). Measurements of nonambipolar and ambipolar radial transport show that these transport processes, as well as end losses, can be controlled at modest densities and durations. Central-cell heating methods using ion-cyclotron heating (ICH) and neutral-beam injection have been demonstrated. Potential measurements with recently developed methods indicate that deep thermal barriers can be established.

**7758 One-dimensional transport models with local and nonlocal lower-hybrid-drift waves in field-reversed configurations.** Hamasaki, S.; Gladd, N.T.; Krall, N.A. (JAYCOR, P. O. Box 85154, San Diego, California 92138). *Physics of Fluids;* **29**: No. 12, 4131-4137(Dec 1986).

The one-dimensional transport theory for field-reversed configurations has been reexamined taking into account global lower-hybrid-drift turbulence. Extending previous work for nonlocal electrostatic lower-hybrid-drift theory, the spatial character of lower-hybrid-drift eigenmodes have been determined in the separatrix region of a field-reversed configuration. Surprisingly, it has been found that the transport model based on the more comprehensive "global" theory of the lower-hybrid-drift theory results in transport coefficients which are very similar to those based on the simple "local" lower-hybrid-drift theory. The reason for this is as follows. The nonlocal theory of the lower-hybrid-drift predicts a sequence of eigenmodes with differing eigenvalues and spatial extent. It is found that if a particular eigenmode is considered and the radial points which mark its radial extent are noted, then the eigenfrequency and growth rate associated with that eigenmode will have approximately the same value as the frequency and the growth rate naively calculated on the basis of the local conditions at the radial edges of the eigenmode.

**7759 Simulation study of two-ion hybrid resonance heating.** Riyopoulos, S.; Tajima, T. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712-1060). *Physics of Fluids;* **29**: No. 12, 4161-4173(Dec 1986).

A one-dimensional low-noise, low-frequency electromagnetic particle simulation code that is appropriate for investigation of ion-cyclotron resonance heating (ICRH) is developed. Retaining the hyperbolicity of the electromagnetic waves and exploiting nearly one-dimensional characteristics (perpendicular to the external magnetic field) of the ICRH, the guiding center electron approximation for the transverse electronic current calculation is used. Mode conversion of the incoming magnetosonic wave into the electrostatic ion—ion hybrid mode is observed accompanied by strong ion heating. The dependence of this heating on the different plasma parameters is examined through a series of simulations, focusing mainly on wave incidence from the high field side. Because k/sub parallel/ = 0 in the runs, the conventional Landau damping cannot explain the ion heating. Nonlinear mechanisms for energy transfer are discussed. The numerical results demonstrate the importance of the nonlinear wave—particle interaction for energy absorption during radio-frequency heating in the ion-cyclotron regime.

**7760 Relativistic solitary-wave solutions of the beat-wave equations.** McKinstrie, C.J.; DuBois, D.F. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review Letters;* **57**: No. 16, 2022-2025(20 Oct 1986). Contract W-7405-ENG-36.

The relativistic equations governing the nonlinear interaction of two light waves and a Langmuir wave are shown to admit two classes of solitary-wave solutions. Temporal solitary waves propagate at speeds greater than the speed of light and carry no information. Spatial solitary waves propagate at speeds less than the speed of light and do carry information. The properties of these waves are discussed and the spatial solitary waves are shown to be well suited to the beat-wave acceleration of particles.

**7761 Experimental investigation on electron cyclotron absorption at down-shifted frequency in the PLT tokamak.** Mazzucato, E.; Fidone, I.; Cavallo, A.; Goeler, S. von; Hsuan, H. (Princeton Univ., NJ, USA. Plasma Physics Lab.). *Nuclear Fusion;* **26**: No. 9, 1165-1169(Sep 1986).

The absorption of 60 GHz electron cyclotron waves, with the extraordinary mode and an oblique angle of propagation, has been investigated in the PLT tokamak in the regime of down-shifted frequency. The production of energetic electrons, with energies of up to 300 to 400 keV, peaks at values of the toroidal field (approx. 29 kG) for which the wave frequency is significantly smaller than the electron cyclotron frequency in the whole plasma region. The observations are consistent with the predictions of the relativistic theory of electron cyclotron damping at down-shifted frequency. Existing RF sources make this process a viable method for assisting the current ramp-up and for heating the plasma of present large tokamaks. 5 refs, 8 figs.

**7762 Studies of impurity behaviour in TFTR.** Hill, K.W.; Bitter, M.; Bretz, N.L. (Princeton Univ., NJ, USA. Plasma Physics Lab.). *Nuclear Fusion;* **26**: No. 9, 1131-1141(Sep 1986).

Central medium and low Z impurity concentrations and Zsub(eff) have been measured by X-ray spectrometry in Tokamak Fusion Test Reactor discharges during three periods of operation. These were (1) startup period, (2) Ohmic heating, and (3) Ohmic heating portion of the two neutral beam periods, distinguished mainly by different vacuum vessel internal hardware and increasing plasma current and toroidal field capability. Plasma parameters spanned minor radius a = 0.41-0.83 m, major radius R = 2.1-3.1 m, current Isub(p) = 0.25-2.0 MA, line averaged electron density nbarsub(e) = (0.9-4.0) x $10^{19}m^{-3}$, and toroidal magnetic field Bsub(T) = 1.8-4.0 T. The metal impurities came mostly from the limiter. At low densities tritium or nickel approached 1% of nsub(e) during operation on a TiC-coated graphite or Inconel limiter, respectively. Lower levels of Cr, Fe, and Ni (< or approx. 0.1%) were observed with a graphite limiter at similarly low densities; these elements were removed mainly from stainless steel or Inconel hardware within the vacuum vessel during pulse discharge cleaning or plasma operation on an Inconel limiter and then deposited on the graphite limiter. Hardware closest to the plasma contributed most to the deposits. Subsequent discharges slowly eroded the deposits from the limiter and reduced the metal impurity levels in the plasma. Both total low Z and metal impurity concentrations, relative to nsub(e), decreased approximately exponentially with nsub(e) and increased with Isub(p). The metals showed much larger variations than did low Z elements, dropping to > or approx. $10^{-5}$ nsub(e) at high density. Low Z impurities, mainly carbon and oxygen, ranged from 10% of nsub(e) at low nsub(e) to 3% at high nsub(e) and usually dominated Zsub(eff) and power loss. In low density plasmas with a TiC-coated graphite or Inconel limiter, the respective metals contributed 30-50% of Zsub(eff) and < or approx. 10-20% of the central input power. 17 refs, 10 figs.

**7763 Model for movement of molten limiter material during the ISX-B beryllium limiter experiment.** Langley, R.A.; England, A.C.; Edmonds, P.H.; Hogan, J.T.; Neilson, G.H. (Oak Ridge National Lab., TN, USA). *Nuclear Fusion;* **26**: No. 9, 1243-1246(Sep 1986). Contract AC05-84OR21400.

A model is proposed for the movement and erosion of limiter material during the Beryllium Limiter Experiment performed on the ISX-B Tokamak. This model is consistent with observed experimental results and plasma operational characteristics. Conclusions drawn from the model can provide an understanding of erosion mechanisms, thereby contributing to the development of future design criteria. Letter-to-the-editor. 9 refs, 5 figs.

**7764 Double sawtooth oscillations in the TEXT tokamak.** Kim, S.B. (Texas Univ., Austin, USA. Fusion Research Center). *Nuclear Fusion;* **26**: No. 9, 1251-1256(Sep 1986).

Double sawtooth oscillations have been studied on TEXT during low-qsub(lim) discharges. The relative amplitude profile of double sawteeth during the first disruption exhibits a minimum at the plasma centre. The first disruption is followed by decaying sinusoidal oscillations which can be interpreted in terms of two m = 1 modes. A condition for partial reconnection in terms of the ratio of the two q = 1 radii is obtained with a simple analytical model based on Kadomtsev's argument and is compared with the experimental results. Letter-to-the-editor. 12 refs, 7 figs.

**7765 Perspective on the next ten years in plasma physics.** Killeen, J. (California University, Livermore, CF, USA. Lawrence Livermore National Laboratory. National Magnetic Fusion Energy Computer Center). *Particle Accelerators;* **19**: No. 1-4, 247-255(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

A brief survey of developments in the plasma physics of magnetic-fusion research is presented. The major experimental facilities of the next decade are listed. Eight fusion-physics issues are identified which must be addressed as a complete plasma system in order to reach the goal of a fusion reactor. In order to resolve the

physics issues the results from these new experimental facilities must be augmented by an extensive program of computer modeling. The use of computer models of a magnetically confined plasma and the implementation of these models on the new supercomputer of the next decade are the main topics of this paper.

7766 **Multiple time-scale methods in particle simulation of plasmas.** Cohen, B.I. (Lawrence Livermore National Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 227-236(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

This paper surveys recent advances in the application of multiple-time-scale methods to particle simulation of collective phenomena in plasmas. These methods dramatically improve the efficiency of simulating low-frequency kinetic behavior by allowing the use of a large time step while retaining accuracy. The numerical schemes surveyed provide selective damping of unwanted high-frequency waves and preserve numerical stability in a variety of physics models: electrostatic, magnetoinductive, Darwin, and fully electromagnetic. The paper reviews hybrid simulation models, the implicit moment-equation method, the direct implicit method, orbit averaging, and subcycling.

7767 **Propagation and reflection of finite amplitude ion acoustic solitons in inhomogeneous plasmas.** Imen, K. Los Angeles, CA; University of Southern California (1986). vp. Micrographics Dept., Doheny Library, USC, Los Angeles, CA 90089-0182.

Many theoretical investigations, due to over-simplification of basic equations or incorrect assumptions, have yielded conflicting predictions of the behavior of ion-acoustic waves in plasmas. Using a full set of cold-ion fluid equations and a Boltzmann distribution for electrons, both the propagation and reflection of ion-acoustic solitons in an inhomogeneous plasma are studied. Two models for ionization are considered. In the first, it is assumed that thermal electrons are responsible for ionization as is often the case in the positive column of a low-pressure discharge. In the second model, a small group of fast electrons ionizes the plasma as in magnetic multidipole devices. A perturbation theory is developed that gives the local amplitude and speed of the soliton in the weekly inhomogeneous part of the plasma. The results are then compared with those of numerical integration of the basic equations. When the soliton reaches the sheath, the perturbation theory fails, but the results of numerical integration for the two different cases of biased and floating potential electrodes show various things regarding the soliton, which are discussed here.

7768 **Recent results for TFTR.** Strachan, J.D. (Plasma Physics Lab., Princeton Univ., P.O. Box 451, Princeton, NJ 08544). pp 2 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The research goals of the TFTR are to study and understand plasma confinement of reactor grade fusion plasmas, and to demonstrate energy-breakeven with deuterium-tritium plasma. TFTR had its first plasma in December 1982; the last operating period June 1984 to April 1985 was devoted to attaining the full operating parameters of the tokamak (toroidal magnetic field of 5.2 T at R = 2.48 m and a plasma current of 2.5 MA), and to study initial neutral beam heating experiments at low power. These neutral beam experiments had 2 Co tangential beams with up to 6.3 MW of 80 kV $D^0$ beams. Since then the internal vacuum-vessel hardware of toroidal small major-radii carbon limiter, carbon title projection plates for neutral beam shine-through, and ZrAl surface pumping panels have been installed. In addition the remaining 2 neutral beam lines were installed giving a 3 Co and 1 counter tangential configuration. The present neutral beam power levels are $\approx$ 10 MW and $\approx$ 20 MW is expected by mid 1986. Experiments on TFTR are aimed at making the most use of those features in which TFTR has unique capabilities in relation to other present large tokamaks. These capabilities include compression, parallel neutral beam injection, high toroidal magnetic field, pellet fueling, and nuclear hardened diagnostics. These capabilities lead the authors to examining plasmas with very low densities and high ion energy content, plasmas with high densities and high central confinement times; as well as plasmas with detachment from limiter contact.

7769 **Gun plasma injection studies in IMS.** Anderson, D.T.; Anderson, F.S.B.; Doerner, R.P.; Probert, P.H.; Shohet, J.L.; Talmadge, J.N. (Torsatron-Stellarator Lab., Univ. of Wisconsin-Madison, Madison, WI 53706). pp 40 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

Gun plasmas have been injected into the Interchangeable Module Stellarator (IMS) using a variety of hydrogen-occluded-titanium configurations. Central plasma densities of up to 5 x 10/sup 12/ cm/sup -3/ have been obtained with significantly flatter density profiles as compared to ECR-produced plasmas at the same field strength. The injected plasmas were observed to possess relatively fast density decay times (200-400$\mu$s) which were only weakly dependent upon the magnetic field strength. Injection for both perpendicular and parallel gun configurations was extremely sensitive to gun placement, with significant plasma flux streaming into the naturally occurring divertors as evidenced by both divertor shield measurements and photographs. The plasma appears to follow flow lines in the field which are significantly different in IMS from those in the Proto-Cleo Stellarator (although the machines are extremely similar in magnetic topology internal to the separatrix). Detailed results of the investigations are presented along with possible explanations of the observed injection process.

7770 **ECH stochastic heating in the Proto-Cleo Torsatron.** Goes, L.; Treffert, J.; Shohet, J.L. (Torsatron-Stellarator Lab., Univ. of Wisconsin-Madison, Madison, WI 53706). pp 40 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The characteristics of ECH plasma build-up on the Proto-Cleo Torsatron are compared with a stochastic model of ECR interaction in a multi-moded cavity resonator. The production of high-energy breakdown electrons (indicated by enhanced second-harmonic microwave emission amd SXR is interpreted by enhancement of the ECH stochastic heating rate due to the effects of the large helical magnetic field ripples. The experimentally determined ionization rates and confinement times are paired with a zero-D ECH evolution code.

7771 **The establishment of the electrostatic field in a stellarator.** Shohet, J.L.; Hitchon, W.N.G. (Torsatron-Stellarator Lab., Univ. of Wisconsin-Madison, Madison, WI 53706). pp 40 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

A particle-in-cell transport simulation has been developed to model the evolution of electrostatic potentials in stellarators. The analysis is done by decomposing a poloidal cross-section. The code uses a rectangular grid, one axis of which corresponds to the poloidal angle and the other to the minor radius. In the former direction, periodic boundary conditions are applied. In the latter, a reflecting boundary is used on the "inside" and an absorbing boundary on the "outside". The toroidal angle corresponds to the third coordinate. An analytic vacuum stellarator field was used in the simulation to observe the evolution of the surfaces of constant electric potential. In this case, the configuration is iota=3, 7 field periods. The e=3 nature of the surfaces is clearly evident. The surfaces are followed for the same toridal angle and thus the vertical deflection is a measure of the rotational transform, which is seen to monotonically increase, and has a value of .6 at the outside edge. The surfaces are seen to be similar, but not identical, to the magnetic surfaces.

7772 **TMX-U tandem mirror experiments.** Simonen, T.C.; TMX-U Group. (Lawrence Livermore National Lab., Livermore, CA 94550). pp 42 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract W-7405-ENG-48.

This paper describes results from TMX-U and compares them with Gamma 10, TARA and Phaedrus. TMX-U employs minimum-B end cells connected directly to the central cell in a compact but nonaxiaymmetric design. TMX-U operates in two modes. The sloshing ion mode is powered only by neutral beams, with

ECRH used for startup. Plasma densities are near 10/sup 13/cm/sup -3/, average ion energies a few keV and electron temperatures up to 160eV. More recent experiments have concentrated on the thermal barrier mode. A 28 GHz gyrotron is used in each end cell to create energetic (100-400keV) mirror-confined electrons by second harmonic ECRH. Sloshing ions are injected at 40° or 47°, into the end cells with 20kV-neutral beams delivering up to 100 atom amperes. The sloshing ions, together with the hot electrons in the minB end cells, provides central-cell MHD stability. A second 28 GHz gyrotron in each end creates plasma potentials to confine central-cell ions. Central-cell ions are heated by ICRH to 0.2 and 2keV energies parallel and perpendicular to the magnetic field lines. Central-cell electron temperatures have reached 0.29keV. In addition, low energy neutral beams (2kV-150 atom ampere total) are used to fuel the central cell. TMX-U operates in the thermal barrier mode at densities up to 1.4 x 10/sup 12/cm/sup -3/ with negligible end loss and up to 3 x 10/sup 12/cm/sup -3/ transiently or with less strong axial confinement. Ongoing experiments are aimed at increasing the central-cell density to 10/sup 13/cm/sup -3/. For comparison the axisymmetrized Gamma 10 has achieved 4 x 10/sup 12/cm/sup -3/ with parties confinement times exceeding 200 msec. Experiments in Phaedrus have reached 10/sup 13/cm/sup -3/ ICRH-produced confinement.

7773 **Investigation of magnetic field surfaces on the Auburn Torsatron.** Gandy, R.; Swanson, D.G.; Barry, B.; Hanson, J.; Henderson, M.; Tarr, R. (Auburn Univ.). pp 40 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The Auburn Torsatron is a iota=2, m=10 steady-state device. It has a major radius of 58 cm, minor radius of 14 cm, and a maximum magnetic field of 2 kG. As originally designed and operated it exhibited an X-point magnetic field structure. The X-point appears in computed magnetic field surface of section plots as well as experimental measurements. Further computer calculations indicated that the X-point could be eliminated by the addition of a centrally located vertical field coil. Recent experimental evidence confirms the transition from X-point to O-point magnetic topology. Several experimental methods have been used in the study of the magnetic field of the Auburn Torsatron. One technique of magnetic field determination involves an electron gun whose resulting beam is detected using two rotatable wires. A second method of B-field mapping involves the use of a Langmuir double probe. As a third method of surface mapping the authors have used a movable emissive filament.

7774 **Electron acceleration by self-generated stochasticity.** Goedde, C.G.; Lichtenberg, A.J.; Lieberman, M.A. (Dept. of Electrical Engineering and Computer Sciences and the Electronics Research Lab., Univ. of California, Berkeley, CA 94720). pp 90 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

A plane-parallel plate r.f. discharge can be used to study intrinsically stochastic r.f. heating. A simple calculation in the collisionless limit shows that the idealized discharge behaves as a standard mapping with a transition from regular to stochastic motion as the discharge parameters (such as r.f. frequency) are varied. An exact integration in an idealized sheath has been used together with the electron drift within a field-free plasma to construct an area preserving mapping. From this mapping the quasi-linear diffusion coefficient can be calculated. This allows an analytic calculation of the electron distribution and temperature, as well as detailed particle and energy balance calculations to determine the minimum pressure to maintain the discharge and the fractional ionization.

7775 **Operation of a reversed field pinch without a conducting shell.** Robertson, S.; Schmid, P. (Univ. of Colorado, Boulder, CO 80309). pp 78 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The Reversatron RFP (R/a=50 cm/8 cm) has been operated with the equilibrium in major radius provided by either an aluminum shell of 22 mm thickness or by a preprogrammed vertical field. With the shell, discharges lasting up to 400μs. With the shell removed, RFP discharges are obtained with I/sub p/ ≈ 23 kA when the vertical field (index = 0.6) is adjusted to 60%-140% of the Shafranov value. The best discharges are obtained at the Shafranov field or a little below. Dynamo activity is observed.

7776 **Large non-circular RFP experiments at Wisconsin.** Sprott, J.C.; Dexter, R.N.; Prager, S.C.; Almagri, A.F.; Assadi, S.; Sarff, J.S. (Univ. of Wisconsin, Madison, WI). pp 79 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

By removing the internal rings from the Levitated Octupole vacuum vessel, a large, non-circular RFP was produced. The major radius is 1.39 m, and the cross section is about 1 m/sup 2/. The device is unconventional in that the vacuum vessel, which consists of 5-cm thick aluminum with a single poloidal and toroidal gap, serves as the vacuum liner, conducting shell, and poloidal and toroidal field coils. A toroidal field of up to about 1 kG can be produced, and the poloidal field is driven by a 600 kJ capacitor bank through a 2-volt-second iron core. Discharges are initiated with 4200 volts per turn using self-reversal of the toroidal field in order to prevent arcing of the poloidal gap which is exposed to the plasma. The gap is protected with a 20-cm wide strip of ceramic. The best RFP discharges have a peak current of ≈200 kA and a duration of ≈ 10 msec. The toroidal field reverses when the current reaches ≈100 kA, making this one of the lowest current density RFP's in existence. The current ramps up to the final value over ≈10 resistive diffusion times and terminates only because the volt-second limit of the iron core is reached. The F-$\theta$ trajectory lies slightly to the right of the $\lambda$=constant theory as do all other RFP devices. Discharges have been produced with $\theta$ up to 2.5 and F as low as -0.8. A feature of the device is that it is capable of producing discharges with plasma current of ≈100 kA and ≈10 msec duration over a wide range of safety factor from the q>1 tokamak limit to the deeply-reversed, RFP limit. The highest current discharges (≈300 kA) are obtained at q≈0.5.

7777 **The time-of-flight neutral particle analyzer on the Tandem Mirror Experiment-Upgrade.** Carter, M.R.; Nexsen, W.E. pp 85 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The authors have recently installed a time-of-flight (TOF) neutral particle analyzer on the east end cell of the Tandem Mirror Experiment-Upgrade (TMX-U). The TOF analyzer consists of a modified turbo-molecular pump for use as a particle chopper, a 7-meter flight path and a secondary emission type particle detector. The TOF analyzer is designed to measure the velocity distribution of escaping charge exchange neutral particles ($D^0$) with energies between 20 and 5000eV. The analyzer is presently viewing the midplane of the east plug at an angle of 22.6 degrees with respect to the magnetic field. This location and orientation is within the magnetic loss cone of the end cell. This allows study of the velocity distribution of the potentially confined ions. Initial data have shown an increase in signal magnitude during operation with end plugging.

7778 **Phased antenna experiments in the central cell of Phaedrus** B. Majeski, R.P.; Browning, J.J.; Ferron, J.R.; Hershkowitz, N.; Intrator, T.; Goulding, R.H.; Breun, R.A.; Pew, J. (Nuclear Engineering Dept., Univ. of Wisconsin, Madison, WI 53706). pp 85 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Phaedrus B is an RF-sustained tandem mirror with ICRF heating in the central cell and in each end cell. Presently there are two sets of ICRF antennas in the central cell. Each set consists of two closely spaced (7.5 cm center to center) double half-turn antennas, with leads azimuthally displaced by 90° to avoid antenna - antenna inductive coupling. The two antenna sets are located 50 cm to either side of midplane in the central cell. Currently there are two transmitters available for ICRF experiments in the central cell, each capable of delivering > 200 KW to the plasma. When Phaedrus B is operated without ICRF in the end cells, MHD stability of the central cell plasma depends on ICRF-driven radial ponderomotive force effects. Stability is dependent on both near field and far field (wave propagation) effects. In previous experiments, it was observed that stability was a strong function of (ω/ω/sub ci/), where ω is the ICRF frequency and ω/sub ci/ is the ion cyclotron frequency in the central cell (typically 8 x 10/sup 6/ rad/sec in Phaedrus B). This effect was attributed to the change in near and wave fields, and their radial gradients, as (ω/ω/sub ci/) is varied through unity. Here the authors present experiments in which the relative phase of two antennas in the central cell is varied, thereby selecting particular wave modes, and their associated radial field profiles, for preferential excitation. Such selectivity allows investigation of ponderomotive force effects without the changes in plasma parameters associated with varying the ratio (ω/ω/sub ci/).

7779 **Negative potential mode in RFC-XX-M.** Garner, H.R.; Price, H.D.; Howald, A.M.; Leikind, B.J.; Parks, P.B. (GA Technologies Inc., P.O. Box 85608, San Diego, CA 92138). pp 86 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

RFC-XX-M is a tandem mirror with cusp anchor/plugs which is magnetically axisymmetric. One of the operating modes of the device exhibits a negative space potential. The plasma is sustained by ICRH alone. The negative potential mode can be maintained for more than 100 ms. Experimental, theoretical, and computational results are given which describe how the mode is formed and maintained. The mode exhibits an axial potential profile which is most negative in the high field region between the central cell and the anchor/plug. This "barrier" is presumably formed by a combination of strong ICRH scattering of ions into the loss cone and nonadiabatic effects. The basic parameters for this mode are: n ≈ 1 x 10/sup 13/ cm/sup -3/, T/sub iperpendicular/ ≈ 500 eV, Tε ≈ 25 eV, and the maximum negative potential measured is ≈ -500 V.

7780 **Recent TMX-U central cell heating and fueling experiments.** Hooper, E.B. Jr.; Barter, J.; Dimonte, G.; Falabella, S.; Molvik, A.W.; Pincosy, P.; Turner, W.C. (Lawrence Livermore National Lab.). pp 86 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—). Contract W-7405-ENG-48.

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Recent experiments have begun to test new methods of heating and fueling of the TMX-U central cell plasma. Heating is with ICRH and 2kV neutral beams. Fueling is by the 2kV beams and by gas puffing. The ICRH system used for fundamental-frequency slow-wave heating consists of two double half-turn antennas, with one on each side of the central cell midplane at mirror ratios of 1:3 and 1:5. Gas fueling is between these two antennas to ensure that recently ionized particles pass through an ICRH resonance before entering the thermal barrier and cells. In recent gas-fed experiments with 100 to 200kW power on each antenna, the end loss temperature was measured to increase from 30eV to above 150eV with perpendicular (cc) temperatures of >500eV. The TMX-U central cell has been equipped with 10 low energy neutral-beam injectors (LENI). These beams are designed to operate at 2kV (net) accel-voltage and deliver 17 atom amperes each to the TMX-U plasma. This low energy was selected to improve trapping (relative to higher energy) on the initial ICRH heated plasma (2X10/sup 12/ cm/sup -3/). At 2keV the beams are predicted to be capable of building up and fueling to 10/sup 13/ cm/sup -3/ density, with ion-ion scattering providing a warm, isotropic ion component in the central cell.

7781 **Flow velocities in the P.S.-3.5 spheromak.** Peyser, T.; Goldenbaum, G.C.; Antoniades, J. (Lab. for Plasma and Fusion Energy Studies, Univ. of Maryland, College Park, MD 20742). pp 16 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The authors have investigated flow fields in the P.S.-3.5 spheromak by observing shifts of spectral lines from carbon impurity ions in the plasma and assuming the shifts are due to the Doppler effect. By passing the plasma light through a spectrometer and imaging it on the detector head of an optical multichannel analyzer (OMA), both spectral and spatial resolution are obtained during a short time interval (2.0 μsec). By comparing the spectral data from the plasma with know lines from a standard lamp, absolute line shifts of +..02A can be determined. The optical system accepts the light emitted side-on (i.e., along a line perpendicular to the plane containing the spheromak symmetry axis) so as to enable toroidal and radial flows to be detected on the midplane of the spheromak. The results reported here are based on observations of the 2297A line of C III.

7782 **Measurements of particle diffusion in the proto S-l/C Spheromak.** Meyerhofer, D.D.; Levinton, F.M.; Yamada, M. (Princeton Univ., Princeton, NJ 08544). pp 77 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The basic setup consists of a local arc discharge and a visible spectrometer. An arc discharge is drawn between two graphite tips (≈ 3mm diameter) separated by a gap of 1mm. A discharge with a peak current of ≈ 6 kA and a pulse width of ≈ 5 μsec is created with a 12kV, 2μf capacitor. This discharge is created at the tip of a probe, is injected into the center of the plasma and gives a localized source of impurity test particles. A visible spectrometer views the plasma region near the discharge through a fiber optic cable and a lens at the machine. The lens and fiber optic holder can be moved in the major radial direction so the the radial and temporal evolution of the injected impurities are monitored. The radial resolution of the optical system is roughly 2mm in the plasma. A major result, determined from observing the 4266 A line of Carbon II, is that the particle diffusion coefficient is found to be larger while the plasma is undergoing Taylor Relaxation, than during the decay phase after the plasma has moved towards a minimum energy state.

7783 **A three-channel plasma diagnostic data handling system based on the VAX 11/780 and the LeCroy 3500 Signal Analyzer.** Ghayspoor, R.; Roth, J.R. (UTK Plasma Science Lab., Dept. of Electrical Engineering, Univ. of Tennessee, Knoxville, TN 37996-2100). pp 96 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Due to a nonlinear characteristics of data obtained by most plasma diagnostic systems and considering the time required for processing these data, computers are an important element of the data handling system in plasma labs. The objective of this work is to develop an integrated data acquisition and handling system based on digital time series analysis techniques. These techniques will enable an understanding of the nature and origin of the plasma fluctuations and their connections to the fluctuation induced transport rate. The approach is to digitize the data, and to generate various spectra by means of Fast Fourier Transforms (FFT). Of particular interest is the computer generated auto-power spectrum, cross-power spectrum, phase spectrum (Channel 1 vs. Channel 2, and Channel 1 vs. Channel 3), squared coherency spectrum (Channel 1 vs. Channel 2, and Channel 1 vs. Channel 3), and transport spectra. Software programs based on those developed at the University of Texas are utilized for these spectra. In this work, the potential fluctuations are measured by two capacitive probes (Channel 1 and 2)

separated by a known angle at the same radius. Channel 3 measures ion density fluctuations with a Languir probe.

7784 **Temporally resolved spectroscopy of laser induced carbon ablation plasmas.** Meachum, J.; Brake, M.L.; Gilgenbach, R.M. (Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI 48109). pp 97 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Temporally resolved emission spectra (360 nm - 630 nm) of carbon ablation plasmas produced by a 25 ns duration, 1 Joule ruby laser pulse are presented. A 0.275 m spectrograph coupled to a gated optical multichannel analyzer (OMA) was used in order to obtain temporally resolved optical spectra of the laser induced plasmas. The target was a 0.238 cm thick block of POCO graphite, positioned such that the laser was incident perpendicular to the surface. The OMA was gated with pulse widths of 50ns and the gates were moved in 10 ns intervals relative to the laser pulse. The resulting emission spectra revealed lines originating from CIV and CIII during the laser pulse and then the growth of CII lines after the laser pulse, simultaneous to the decrease of CIV and CIII lines. CI lines were never observed, however the ion streaming velocity is about 1x10/sup 7/ cm/sec and the plasma moved out of the field of view by the time CI would have been present. Temperature of the plasma as a function of time can be estimated from the corona model. The plasma is about 9 eV during the laser pulse and cools to about 4 eV by 100 to 200 ns after the laser pulse.

7785 **Time-resolved Thomson spectrometer study of plasma focus produced ions.** Weidman, D.J.; Rhee, M.J.; Schneider, R.F. (Univ. of Maryland, College Park, MD 20742). pp 88 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The Thomson spectrometer is a very useful diagnostic for ion beams since it provides the distribution of particles as a function of energy, momentum, and charge-to-mass ratio, simultaneously. No temporal information, however, is provided. The authors describe a time-resolved Thomson spectrometer experiment, the results of which will provide temporal information for a better understanding of the plasma focus. The time-integrating Thomson spectrometerr used hitherto utilizes parallel E and B fields, which are produced by a pair of permanent magnets which also serve as electrodes. Etched particle tracks produce a pattern on a detector plate made of CR-39 plastic. The pattern of an unmodulated, time-integrated spectrogram consists of parabolas, where different parabolas indicate different charge-to-mass ratios. In the time-resolving Thomson spectrometer, the electric field is modulated by varying the voltage on the electrodes. The resulting modulation in track shape on the CR-39 detector can then be interpreted in terms of the voltage modulation and the temporal distribution of particles at the source. A modulation in the form of a voltage step (which reduces the E field) truncates the parabolas. Only those particles arriving at the spectrometer before the step form parabolas; those particles arriving after the step lie much closer to one axis. A square pulse modulation that reduces the E field for a very short period of time greatly reduces the density of particle tracks at one section of each parabola; this is analogous to closing a camera shutter for a brief moment during an open shutter photograph.

7786 **Root-mean-square emittance of plasma focus particle beams.** Schneider, R.F.; Namkung, W.; Rhee, M.J.; Smith, J.R.; Weidmann, D. (Lab. for Plasma and Fusion Energy Studies, Univ. of Maryland, College Park, MD 20742). pp 10 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

A compact plasma focus device has been studied as a source of intense electron and ion beams. The device consists of a 15 microfarad, 3 kilojoule capacitor connected to Mather geometry plasma focus electrodes by a spark gap switch. During the focus stage, the intense particle beams are accelerated in opposite directions. The electron beam may be characterized by the following parameters: f 5 ns, f 5 kA, f 100 keV. The ion beam is composed of ions and neutrals of the various filling gases as well as impurities. Energies into the MeV range are evident from Thomson spectrograms. The root-mean-square (rms) emittance of both particle beams is obtained with a simple emittance meter which consists of a series of parallel slits and an appropriate detector. For the electron beam, a radiachromic film is placed 4.32 mm behind the slits. Subsequent to exposure the film is scanned with an optical microdensitometer along the axis perpendicular to the slits. With the assumptions of a non-rotating beam with Maxwellian velocity distribution, the rms emittance may be calculated. It is found to be f 1 cm-rad. For the ion beam, a CR-39 detector is placed 8.36 mm downstream of the slits. The track distribution along the axis is obtained by counting the individual tracks. The rms emittance of a portion of the ion beam selected by an aperture is f 5.0 cm-rad. Analysis of experimental results are presented.

7787 **Recent results from the ZT-P experiment.** Schoenberg, K.F.; Burkhardt, L.C.; Haberstich, A.; Melton, J.G.; Reass, W.; Weber, P.G.; Wurden, G.A. (Los Alamos National Lab.). pp 18 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The ZT-P experiment, with a major radius of 0.45 m and a minor radius of 0.07 m, was designed to prototype the next generation of reversed field pinch machines at Los Alamos. ZT-P utilizes an air-core poloidal field system, with precisely wound and positioned rigid copper coils, to drive the plasma current and provide plasma equilibrium with intrinsically low magnetic field errors. ZT-P also incorporates a modular design to facilitate assembly and disassembly and allow for rapid replacement of various liner/shell assemblies. The primary mission of ZT-P is to aid in the engineering design of the Los Alamos CPRF/RFP facility and to complement the RFP physics research presently under investigation on ZT-40M. ZT-P will provide a test bed for many engineering aspects of large air-core machine design. These include, but are not limited to, plasma formation and equilibrium control with an aircore system, performance and reliability of the aircore poloidal and toroidal field circuit design, data acquisition and experimental control in the presence of high ambient magnetic fields and transient voltages.

7788 **Two-dimensional modeling of the plasma opening switch.** Payne, S.S.; Hussey, T.W.; Stinnett, R.W.; Roderick, N.F. (Sandia National Labs.). pp 25 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

Experimental and theoretical studies at the Naval Research Laboratory, as well as recent experiments at Sandia National Laboratories, indicate that plasma opening switches with conduction times of near 100 nsec and opening times of less than ten nano-seconds are obtainable. Theoretical studies of such switches have emphasized particle dynamics near peak current, looking at the erosion process. Analysis of magnetic probe data, as well as damage patterns from recent Supermite experiments at Sandia, suggest that J-vector x B-vector forces during the conduction phase at an early time are important. For relatively high-density plasmas (≧ 10/sup 13/cm/sup -3/) in which charge separation is unimportant, one can consider a fluid model for this conduction phase. The authors have considered such effects both analytically and numerically. Magnetic field penetration can be solved for analytically in one dimension assuming a linearly rising current, as one can snowplowing of undisturbed plasma due to J-vector x B-vector forces. Including these effects simultaneously, however, requires a full magnetohydrodynamic (MHD) simulation. The authors have used the two-dimensional, Eulerian MHD code, HAM, to calculate these effects as well as to consider field nonuniformity effects associated with coaxial geometry. Drift velocities from these calculations are given as a function of time for a variety of initial conditions, and estimates are made of plasma conditions at the onset of erosion. In particular, the effect of radial inflow of plasma is considered.

7789 **Particle-in-cell simulations of heavy ion plasma double layers.** Peratt, A.L.; Jones, M.E.; Torven, S. (Los Alamos National Lab.). pp 73 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

An investigation of the temporal evolution of double layers (DL) formed in aluminum, argon, and mercury plasmas have been carried out with the particle-in-cell code ISIS. The simulation geometry consists of a plasma gun, a grid, and a transparent anode. Electrons and ions are emitted from the gun with an injection potential of 20V. The electrons then stream through the grounded grid towards the anode biased, typically, at a potential between +100V and +500V. The electrons depress the initially positive linear potential profile between the grid and anode negatively, allowing the massive ions to follow. After a few μs transit time, the ions are reflected at the anode. At this time, the plasma consists of both positive and negative particle velocity distributions. Because of the counterstreaming particles, an instability develops producing phase space "vortices" analogous to those of virtual cathode oscillators. These are accompanied by ion trapping, the buildup of a large virtual anode near the grid, the acceleration of electrons to high energies, and a burst of noise. A discussion of DL formation in simulations of the Triple Plasma Device is given.

7790 **Trapping and pumping of ions in the thermal barrier region of Phaedrus-B, a tandem mirror.** Breun, R.; Radtke, J.; Butz, G.; Brouchous, D.; Conrad, J.; Peranich, L.; Persing, H. (Univ. of Wisconsin, Madison, Madison, WI 53706). pp 85 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

One of the objectives of Phaedrus-B, a five cell thermal barrier tandem mirror, is to test rf drift pumping in a separate inboard thermal barrier cell. This cell has a peak field of 9.25 kG at the choke coil, a minimum field of 2.1 kG, and an outer maximum of 6.5 kG at the plug throat. The circular central cell flux tube becomes highly elliptrical as it passes through the thermal barrier cell and thus curvature drift perpendicular to the flux surface, geodesic curvature drift, is present. Inside the thermal barrier a drift pump antenna has been installed that ripples the field approximately 1 cm at 110 kHz. This ripple field is designed to resonate with the bounce motion of the trapped ions enhancing those ions radial motion to such an extent that the local density is kept at 2-3 times the passing ion density and 1/5 the central cell density. This creates a potential dip which thermally isolates the central cell electrons from the plug electrons. Initial studies are concentrating on identifying the trapping mechanisms of the ions in the thermal barrier region and the effects of single frequency pumping in one thermal barrier cell. Startup involves buildup of a central cell plasma of 3-7 x 10/sup 12/ cm/sup -3/ with local ECRH and ICRH.

7791 **Root-mean-square emittance of plasma focus particle beams.** Schneider, R.F.; Namkung, W.; Rhee, M.J.; Smith, J.R.; Weidmann, D. (Lab. for Plasma and Fusion Energy Studies, Univ. of Maryland, College Park, MD 20742). pp 88 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

A compact plasma focus device has been studied as a source of intense electron and ion beams. The device consists of a 15 microfarad, 3 kilojoule capacitor connected to Mather geometry plasma focus electrodes by a spark gap switch. During the focus stage, the intense particle beams are accelerated in opposite directions. The electron beam may be characterized by the following parameters: ≈ 5 ns, ≈ 5 kA, ≈100 keV. The ion beam is composed of ions and neutrals of the various filling gases as well as impurities. Energies into the MeV range are evident from Thomson spectrograms. The root-mean-square (rms) emittance of both particle beams is obtained with a simple emittance meter which consists of a series of parallel slits and an appropriate detector. For the electron beam, a radiochromic film is placed 4.32 mm behind the slits. Subsequent to exposure the film is scanned with an optical microdensitometer along the axis perpendicular to the slits. With the assumptions of a non-rotating beam with Maxwellian velocity distribution, the rms emittance may be calculated. It is found to be ≈ 1 cm-rad. For the ion beam, a CR-39 detector is placed 8.36 mm downstream of the slits. The track distribution along the axis is obtained by counting the individual tracks. The rms emittance of a portion of the ion beam selected by an aperture is ≈ 5.0 cm-rad. An analysis of experimental results is presented.

7792 **Correlation of D-D neutron yield and D/sup +/ energy spectrum in focused discharges.** Nardi, V.; Luo, C.; Powell, C.; Bortolotti, A.; Mezzetti, F.; Kuharetz, B. (Stevens Institute of Technology, Hoboken, NJ 07030). pp 88 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The energy spectrum N(E) of the D/sup +/ ion emission from ≈ 0.6 MA focused discharges is determined with Thomson spectrometers for different conditions (D/sub 2/ filling pressure, capacitor bank voltage, and geometry of field distortion elements in the interelectrode gap). Linear correlation coefficients c/sub i/ for a characteristic element of the spectrum (e.g. the spectrum amplitude within a selected energy interval E, E+ΔE) and the neutron yield n is determined for a large number of discharges. The interplay of two leading processes in the neutron production, ion acceleration and ion trapping in the self magnetic field of the pinch, is analyzed in terms of correlation coefficients c/sub i/ and peak neutron energy.

7793 **Hydromagnetic Rayleigh-Taylor instability in cylindrical implosions.** Hwang, C.S.; Roderick, N.F.; Wu, M.W. (Univ. of New Mexico, Albuquerque, NM). pp 73 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Rayleigh-Taylor Instability in the (r,Θ) plane has been solved by the variational approach. Results are compared to the analytical solutions of two-region and three-region problems at the infinite radius. They show the magnetic stabilization effect. Growth rates in this plane are decreased by the effects of plasma shell thickness, plasma shell radius, magnetic tension, magnetic diffusion and finite density gradient of the plasma magnetic field interface. The most unstable mode number decreases when the radius of the plasma shell decreases.

7794 **On the two-dimensional evolution of an ion-acoustic soliton.** Chang, H.Y.; Lien, C.; Lonngren, K.E.; Gabl, E.F. (The Univ. of Iowa). pp 72 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Effects of small transverse perturbations on the propagation of ion-acoustic solitons are experimentally investigated by launching the solitons from non-planar structures. These solitons can be described by the higher dimensional Kadomtsev-Petviashvilli (KP) equation. Theoretical and numerical studies of the KP equation show that the KP solitons evolve in space into one dimensional Korteweg-deVries (KdV) solitons which is in agreement with the experimental observations.

7795 **Radiation pressure on moving plasma.** Kalluri, D. (Univ. of Lowell, Lowell, MA). pp 72 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Mechanical power P/sub m/ has to be supplied to maintain the movement of a conductor with a uniform velocity v against the radiation pressure of an electromagnetic wave. In the case of a dielectric the force is in the opposite direction. The authors compare the normalized force for the case of a conductor, dielectric and plasma. Several other comparisons and their significance are presented.

7796 **Effective collision frequency measurements on a weakly ionized turbulent plasma.** Spence, P.; Roth, J.R. (UTK Plasma Science Lab., Dept. of Electrical Engineering, Univ. of Tennessee, Knoxville, TN 37996-2100). pp 75 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Effective collision frequencies have been measured using resonant absorption of an extraordinary wave propagating across a plasma column. Both the attenuation and phase shift of a transmitted wave are measured in a swept frequency measurement using an HP 8510 Network Analyzer. The measured attenuation and phase shift at and near a resonant frequency are compared to a numerical solution of the Appleton equation using relevant plasma parameters. The width at twice the minimum transmitted power at resonance is taken to be an "effective" collision frequency. This definition agrees with the solution of a forced-damped harmonic oscillator and numerical solutions of the Appleton equation. The steady state plasma column used for the experiment is generated by a classical Penning discharge. Electron number densities are obtained with electron temperatures typically 10 eV. The plasma is typically only $\approx 1\%$ ionized so that electron-neutral collisions would normally dominate. The collision frequencies measured are 2 to 20 times electron-neutral collision frequencies computed using tabulated cross sections. A strong dependence on the static magnetic field is observed. The effective collision frequency increases with static magnetic field. These anomalous collision frequencies are believed to be related to the high level of electrostatic turbulence associated with the discharge.

7797 **Shock and magnetosonic waves in a Mather-type plasma focus.** Gerdin, G.; Venneri, F.; Boulais, K. (Fusion Studies Lab., Univ. of Illinois, 103 S. Goodwin Ave., Urbana, IL 61801). pp 89 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

A fast streak camera has been used to measure the speeds of the axially propagating transverse ionization wave (or rundown phase), the radial collapse, and what appears to be a magnetosonic compression wave propagating along the pinch. The current flowing in the moving current sheath was measured by means of a magnetic probe placed between the coaxial electrodes. The magnetic probe is necessary to determine the pinch current since the device current does not always entirely flow in the current sheath (CS). The CS current was varied from about 200 to 800 kA in the experiments reported here at a static fill of 3 Torr of deuterium. All three velocities were found to be linear with the CS current as predicted from simple models with less than a 10% uncertainty in the least squares slope. The axial or rundown speed was found to be consistent with the constant speed model of v/sub AX/ $\approx$ v/sub A//$\sqrt{2}$ where v/sub A/ is the Alfven speed at the surface of the inner conductor. The velocity of the radial collapse was compared with a 4th Order Runge-Kutta solution to the snowplow model or 'M' theory and the agreement was not as good. The magnetosonic scaling with current at constant fill pressure is consistent with a constant mass per unit length being swept up by the snowplow and representing about 1/4 of the original fill gas mass per unit length over the center electrode.

## 7002 Fusion Power Plant Technology

*REFER ALSO TO CITATION(S) 6743, 6995, 7002, 7026, 7027, 7028, 7224, 7225, 7226, 7227, 7228, 7229, 7230, 7231, 7232, 7233, 7234, 7236, 7237, 7496, 7763, 7768, 7780, 7785, 7788, 7788, 7789, 7789, 7791, 7792*

7798 **(CEA-CONF—8074) Instability of interfaces submitted to shock acceleration and deceleration.** Brun, R.; Houas, L.; Froger, A.; Gauthier, S.; Sitt, B. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Aug 1985. 7p. (CONF-850767—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750238.

From 15. international symposium on shock waves and shock tubes; Berkeley, CA, USA (29 Jul 1985).

The purpose of this paper is to present the evolution of a gaseous interface, initially thin and plane, after successive acceleration and deceleration produced by strong shocks. Experimental thickness of different zones are compared to theoretical ones, computed with the aid of a turbulent mixing model.

7799 **(CEA-CONF—8391) Physico-chemical investigations in relation with the tritium circuit in fusion reactors.** Chabot, J.; Courvoisier, P.; Mauvisseau, J.; Sauzay, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Jun 1986. 10p. (CONF-860603—9). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750259.

From 4. European nuclear conference and 9. FORATOM congress (ENC '86) and international nuclear trade fair; Geneva, Switzerland (1 Jun 1986).

The tritium flow diagram within a fusion reactor may be splitted in a series of chemical engineering units. For them, the E.E.C. has launched a review program as well as experimental work. In this framework the CEA has carried out conceptual studies on fuel clean-up process, on gaseous waste treatment and on atmosphere detritiation systems. Moreover measurements with experimental loops are running to determine data necessary to assess unit dimensions; among others: hydrogen permeation rate through Pd-Ag membranes and tritium oxidation catalyst performances.

7800 **(CEA-CONF—8413) Tritum recovery from a breeder material gamma lithium aluminate.** Roth, E.; Botter, F.; Briec, M.; Rostaing, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI); CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 22p. (CONF-860421—64). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750286.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

The paper discusses phenomena that have been observed during tritium extraction from gamma lithium aluminate. - Increase of rate of extraction when adding hydrogen to the flush gas, - formation of tritiated water in all cases - permeation of tritium through gas pipes - adsorption of tritiated water on gas lines. To minimize the effect of these phenomena on inventories a flow sheet is proposed whose specificity rests in the addition of hydrogen to the gas within the blanket, followed by recovery of the tritium after oxidation of hydrogen to water, electrolysis and reconcentration. This flow sheet includes a provision for detritiation of the coolant which is separate from the purge gas.

7801 **(CEA-CONF—8416) Tritium and the controlled fusion reactors.** Leger, D.; Rouyer, J.L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Protection et de Surete Nucleaire). Apr 1986. 25p. (In French). (CONF-8604266—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750287.

From Tritium meeting; Dijon, France (23 Apr 1986).

It is shown how tritium is used how it is circulating in a fusion reactor. The great functions of tritium circuits are detailed: reprocessing of burnt gases, reprocessing of gases coming from neutral injectors, reprocessing from gaseous wastes, detritiation of cooling fluids. Current technologic developments are quoted. Then tritium confinement and containment, in normal or accidental situations, are displayed. Limitation devices of effluents and release for normal operating (noticeably the reprocessing systems of atmosphere) and safety and protection systems in case of accident are described.

7802 **(CEA-CONF—8435) Experimental devices in Osiris reactor to study effects of radiations on fusion reactor materials.** Lefevre, F.; Thevenot, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Apr 1986. 15p. (CONF-860421—63). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750274.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Within the framework of Technology Research Program on controlled fusion initiated by European Communities, the services des Piles de Saclay (S.P.S.) of Commissariat a l'Energie Atomique (C.E.A.) have been requested to realize some necessary irradiations to study the under flux behaviour of materials which are possible candidates for controlled fusion reactor. This paper describes the devices, generally adapted from a standard model "the COLIBRI", which allow to carry out, in the OSIRIS reactor, irradiations on the three great families of fusion reactor materials: lithium containing materials of breeding blanket for in situ tritium production, protection materials, structural materials.

7803 **(CONF-860652—30) Techniques for measurement of velocity in liquid-metal MHD flows.** Reed, C.B.; Picologlou, B.F.; Dauzvardis, P.V.; Bailey, J.L. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001553.

From 7. topical meeting on the technology of fusion energy; Reno, NV, USA (15 Jun 1986).

Three instruments for measuring local velocities in liquid-metal MHD experiments for fusion blanket applications are being evaluated. The devices are used in room-temperature NaK experiments to measure three-dimensional flow field patterns anticipated in complex blanket geometries. Hot film anemometry, a standard technique in ordinary fluids, is being used, as well as two developmental devices. One is called the Liquid Metal Electromagnetic Velocity Instrument (LEVI), and performs essentially as a local dc electromagnetic flow meter. The third device, a Thermal Transient Anemometer (TTA) is a rugged, yet relatively simple device, which measures local velocity through the mechanism of convective heat transfer, in some ways similar to hot-film anemometry. Results are presented showing the kinds of data collected this far with each instrument. Measurements include both local velocity measurements and some preliminary frequency analyses of the fluctuating signals from both a hot-film sensor and the LEVI device.

7804 **(CONF-8608131—Vugraphs) First estimate of PACE cost for CIT design point (R = 1.34 m).** Hamilton, R.; Brown, T. (Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center). 12 Aug 1986. Contract AC05-84OR21400. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87000750.

From Ignition Technical Oversight Committee conference; Los Alamos, NM, USA (12 Aug 1986).

Viewgraphs of the presentation are included. (MOW)

7805 **(DOE/DP/10529—1) SIRIUS-M: a symmetric illumination, inertially confined direct drive materials test facility.** Badger, B.; Abdel-Khalik, S.I.; Attaya, H.M.; Engelstad, R.L.; Kulcinski, G.L.; Liang, J.H.; Lovell, E.G.; Moses, G.A.; Musicki, Z.; Peterson, R.R. (Wisconsin Univ., Madison (USA). Fusion Technology Inst.; Rochester Univ., NY (USA). Lab. for Laser Energetics). Oct 1986. Contract AS08-86DP10529. 142p. (UWFDM—711). NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87002158.

The SIRIUS-M facility uses symmetrically-illuminated targets. It is designed to duplicate the anticipated time-dependent radiation damage structure unique to ICF systems, in order to provide the technology base necessary for an ICF demonstration facility. In order to simplify the design of this first-of-a-kind facility and reduce its capital cost, its "mission" has been limited to materials testing; tritium breeding and high-temperature recovery of thermonuclear energy have not been included.

7806 **(DOE/ER—0045/16) Alloy development for irradiation performance. Semiannual progress report for period ending March 31, 1986.** (Oak Ridge National Lab., TN (USA)). Sep 1986. 215p. D. File Number DE87002337.

Abstracts were prepared for each of the included sections. (MOW)

7807 **(LA-UR—86-3524) Theoretical and experimental studies of field-reversed configurations.** Chrien, R.E.; Hugrass, W.N.; Armstrong, W.T.; Caramana, E.J.; Lewis, H.R.; Linford, R.K.; Ling, K.M.; McKenna, K.F.; Rej, D.J.; Schwarzmeier, J.L. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-861106—12). NTIS, PC A02/MF A01; GPO Dep. File Number DE87001764.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

The FRX-C/T formation region has been enlarged in diameter by 50%, and quasi-steady cusp coils have been installed to compare tearing and non-tearing formation. FRCs with significantly larger poloidal flux ($\leq$8 mWb) and s ($\leq$4) have been formed. However, their flux confinement was degraded compared with earlier FRX-C results. The n = 2 rotational instability has been completely suppressed on translated FRCs in FRX-C/T. Nearly equal stabilization thresholds were observed for straight and helical quadrupole fields, in contrast with another experiment.

7808 **(NRL-MR—5814) High efficiency targets for high gain inertial confinement fusion.** Gardner, J.H.; Bodner, S.E. (Naval Research Lab., Washington, DC (USA)). 19 Sep 1986. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002084.

Rocket efficiencies as high as 15% are possible using short wavelength lasers and moderately high aspect ratio pellet designs. These designs are made possible by two recent breakthroughs in physics constraints. First is the development of the Induced Spatial Incoherence (ISI) technique which allows uniform illumination of the pellet and relaxes the constraint of thermal smoothing, permitting the use of short wavelength laser light. Second is the discovery that the Rayleigh-Taylor growth rate is considerably reduced at the short laser wavelengths. By taking advantage of the reduced constraints imposed by nonuniform laser illumination and Rayleigh-Taylor instability, pellets using 1/4 micron laser light and initial aspect ratios of about 10 (with in flight aspect ratios of about 150 to 200) may produce energy gains as high as 200 to 250.

7809 (UCRL—50007-85, pp 14-18) **Alarm points for oxygen monitors used in the MFTF-B facility.** Miller, G. 1 Jun 1986. NTIS, PC A07/MF A01. File Number DE86014914.

In Hazards Control Department annual technology review, 1985.

Oxygen concentration monitors were installed in a vault where numerous pipes carried inert cryogens and gases to the Mirror Fusion Test Facility (MFTF-B) experimental vessel. The problems associated with oxygen-monitoring systems and the reasons why such monitors are installed were reviewed. As a result of this review, the MFTF-B monitors were set to sound an evacuation alarm when the oxygen concentration fell below 18%. Eighteen percent was chosen as the alarm criterion to minimize false alarms and to allow time for personnel to escape in an oxygen-deficient environment.

7810 **Beryllium limiter experiment in ISX-B.** Mioduszewski, P.K.; Edmonds, P.H.; Bush, C.E. (Oak Ridge National Lab., TN, USA). *Nuclear Fusion;* 26: No. 9, 1171-1192(Sep 1986). Contract AC05-84OR21400.

An experiment to test beryllium as a limiter material has been performed in the ISX-B tokamak. The effect of the plasma on the limiter and the effect of the limiter on the plasma were studied in detail. Heat and particle fluxes to the limiter were measured, and limiter damage by melting was documented as a function of power flux. Strong melting and evaporation of the limiter caused beryllium gettering of the vacuum vessel. Postmortem analysis of the limiter was performed to document the amount of retained hydrogen and the erosion and impurity deposition on the limiter. The effect of the limiter on the plasma performance was studied in terms of parameter space, impurity content, and confinement for the ungettered and gettered cases. Operational experience with beryllium in a fusion experiment is discussed. 23 refs, 21 figs, 10 tabs.

7811 **A brief overview of Tokamak fusion research.** Davis, L.G. (GA Technologies Inc., San Diego, CA 92138). pp 2141-2143 of Proceedings of the 21st intersociety energy conversion engineering conference. Washington, D.C.; American Chemical Society (1986). (CONF-860810—).

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Fusion, the nuclear engine that powers the sun and stars, has been pursued by scientists for decades as the ultimate source of energy. It promises an almost inexhaustible fuel supply with the oceans containing sufficient fusion fuel to outlast the expected life of the sun. Fusion is a process whose waste is inert and whose components know no geographical bounds. Scientists have pondered the laws governing the fusion process since the 1940's, and since the late 1950's laboratory devices have been constructed to test and further develop the theories. To achieve fusion, the joining of light atomic nuclei (as opposed to the splitting of heavy elements in the fission process), the natural tendency of the nuclei to repel each other due to their like electrical charges must be overcome. As the fusion takes place, some of the matter of the nuclei is converted to energy. In the stars fusion is accomplished largely by enormous gravitational forces. On earth the fusion fuel must be heated by other means to increase the energy of the particles to force them to fuse. Therein lies the challenge of fusion research - how to heat sufficient matter to hundreds of millions of degrees and contain it long enough for a controlled and sustained fusion reaction to take place. The method that presently shows the most promise is to contain a plasma (an ionized gas - the fourth state of matter) in a magnetic field while heating the plasma by means of high energy neutral particle beams or radio frequency waves.

7812 **Current transformer for the S-1 Spheromak.** Ellis, R.A. Jr.; Heitzenroeder, P.; Janos, A.; Joyce, J.; Lawn, F.; Yamada, M. (Plasma Physics Lab., Princeton Univ., Princeton, NJ 08544). pp 76 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Recent experimental results have provided evidence that the tendency of spheromak plasmas to reach a minimum energy state called the "Taylor state" can be exploited to increase or maintain the toroidal and poloidal field of spheromak. This paper contains a description of modifications that can increase the toroidal current in S-1 to 1 MA. It is planned to increase the toroidal currents and toroidal fields in S-1 by inducing an incremental toroidal current in the spheromak plasma with a transformer (CT) located on the symmetry axis. According to the Taylor relaxation process, an unrelaxed configuration with excess toroidal current will undergo a resistive reconnection of poloidal and toroidal flux so that the final minimum energy state is a spheromak plasma with large toroidal current and toroidal field. Pulsed equilibrium field (EE-P) coils must also be provided.

7813 **Injection of magnetic fluxes into spheromak plasma thru an inductive transformer.** Yamada, M.; Janos, A.; Jardin, S.; Young, P. (Princeton Univ., Princeton, NJ 08544). pp 76 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

In the low q toroidal pinch plasmas such as spheromaks and reversed field pinch, the magnetic fields evolve in a manner consistent with the principle that plasmas seek the energy minimum state keeping its helicity constant. During this process, a flux-conversion between poloidal and toroidal field plays an essential role. Based on this theorem, one can inject magnetic energy through a current transformer at the major axis just as it is done in Tokamaks. Preliminary experimental evidence from a prototype S-1 device demonstrates the successful use of an poloidal-flux transformer for increasing and prolonging not only the toroidal plasma current but also the toroidal magnetic flux in the plasma. The operation of this type of transformer in S-1/sup 2/ has been simulated using a 2-D computer code model with a term in the mean-field Ohms law which describes 3-D relaxation effects and flux conversion. This simulation has successfully demonstrated that the toroidal current can be increased from an initial level of 0.5 M/sup A/ to the 1.0 M/sup A/ level, while maintaining a relaxed spheromak configuration, for a flux swing of $\approx$ 1 Vsec.

7814 **Magnetic equilibrium determination in the Maryland Spheromak.** Shaw, R.S.; Finn, J.M. (Lab. for Plasma and Fusion Energy Studies, Univ. of Maryland, College Park, MD 20742). pp 77 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The Maryland Spheromak (MS) experiment produces spheromaks by a combination of electrode and inductive discharge techniques, as used on the previous PS experiments. Here, however, the plasma is produced in a metal chamber of radius 50 cm, and length, including smaller diameter expansion chambers, of 210 cm. The applied equilibrium field is quasi-static ($\approx$ 5 sec), while the axial current and reversal field current are pulsed ($\approx$0.1 msec). Because of these timescales, the metal chamber acts as a flux conserver to the reversal field, and does not affect the equilibrium field. The resulting spheromaks have designed fields of up to 25 kG and average current density of $\approx$1 kA/cm/sup 2/. A computer code has been written to solve the Grand-Shafranov equation for the poloidal flux function, where the flux is specified on the MS chamber boundary. Various profiles for the pressure and r.B/sub toroidal/ (I(psi)) are used, and a series of equilibria are produced. In particular, pressure is assumed to be a linear function of poloidal flux, and the eigenvalue k (dI/dpsi) is either a constant or a linear function of flux inside the separatrix, and zero outside. The boundary values are computed from the known positions of the equilibrium field coils.

7815 **Plasma Opening Switch performance on supermite and PBFA II.** Stinnett, R.W.; Gray, E.W.; McDaniel, D.H.; Moore, W.B.; Renk, T.J.; Rochau, G.E.; Woodall, H.N.; Meger, R.A.; Ottinger, P.F.; Commisso, R.J. (Sandia National Labs.). pp 24 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract AC04-76DP00789.

The POS system on PBFA II is unique because of its size and the voltage at which it operates. The PBFA II magnetically-insulated vacuum power feed is a two-sided conical structure which delivers one-half of its current through each side. The entire POS system (four flashboards and four drivers) on PBFA II is contained inside the anode, under vacuum. Currents of 4-5 MA have been conducted for over 50 ns by the PBFA II POS system. The most recent results from the PBFA II POS system tests are presented.

**7816 Plasma opening switch experiments on PBFA I using flashboards.** Renk, T.J.; Zuchowski, N.P. (Sandia National Labs., Albuquerque, NM 87185). pp 24 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract AC04-76DP00789.

The objective of prepulse suppression was met by the carbon plasma gun configuration. Improvements in power flow symmetry, however, were limited by large port-to-port variation in the plasma gun outputs. The large variation in plasma outputs was indicated by Faraday cups and by damage on anode stagnation plates. With the goal of reducing the plasma variation, the authors developed a flashboard system to retrofit to the 18 ports. A single stripline with 9 periodically spaced sets of flashover gaps was energized by a single 1.8 μF capacitor bank with 3 μsec period. Two flashboards and two banks thus replaced the 18 guns and 6 banks. A carbon ballast resistor was added in series to each chain of gaps, both to increase the flux output and to reduce port-to-port fluctuations in plasma. The resultant flux was much more uniform and faster-moving than was seen with the carbon guns. The flashboards have conducted as much as 1 1/2 MA per side (3 MA total), with no evident switch losses, and with steepened current rise into the ion diode. The stand-off distance from the flashboard to the anode stagnation plate is only 5 cm, producing a risetime of the flashboard-produced flux of less than 200 ns.

**7817 The effect of PEOS geometry on current transfer.** Hinshelwood, D.D.; Weber, B.V.; Ottinger, P.F.; Oliphant, W.F.; Neri, J.M.; Meger, R.A.; Commisso, R.J. (Naval Research Lab., Washington, DC). pp 25 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The effect of the radial gaps between conductors, in both the switch and transition regions, is investigated. A 20 cm long PEOS is separated from the load (an inverse diode with an inductive voltmeter) by a 10 cm long transition section. The switch plasma is supplied by twelve Mendel plasma guns. The radial gap between conductors is varied independently in the switch and transition regions from 2 to 4 cm, and on some shots the transition region is removed altogether. For each switch geometry, the load impedance is varied to determine the dependence of current transfer efficiency on this impedance. Results of this investigation and comparisons with theoretical predictions are presented.

**7818 Comparison of Ion Beam opening switch and plasma opening switch performance.** Greenly, J.R.; Rondeau, G.D.; Sheldon, H.T.; Dreike, P.L. (Cornell Univ.). pp 26 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The Ion Beam opening switch (IBOS) experiment has shown that an intense charge-neutralized ion beam can carry current across a vacuum magnetically-insulated transmission line and then transfer that current to a downstream load quickly. In the IBOS experiment, a 10 cm wide parallel plate transmission line was fed up to 100 kA peak current by a 4Ω, 100 ns pulser. An ion beam of up to 100 A/cm/sup 2/, 100-300 keV protons or carbon was injected through the anode of the line in a 10 cm x 10 cm region. The line terminated in either a 15 nH short circuit or an electron diode with variable gap. The ion beam switch was able to carry up to 70 kA of line current before load current began to flow. This model is also quantitatively consistent with the observation that switch conduction current is not linear with either injected ion beam current or switch area.

**7819 Physics and applications of the plasma erosion opening switch.** Weber, B.V.; Boller, J.R.; Colombant, D.G.; Commisso, R.J.; Cooperstein, G.; Greenly, J.B.; Grossmann, J.M.; Hinshelwood, D.D.; Kulsrud, R.A.; Meger, R.A. (Naval Research Lab., Washington, DC 20375-5000). pp 61 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The plasma erosion opening switch (PEOS) is an opening switch that is capable of conducting > 1 MA then opening into a load in les than 10 ns, generating voltages > 1 MV. This technology is being developed in a cooperative effort by NRL and SNL for use on PBFAII. A variety of other applications are being pursued at NRL. Experimental efforts employing the PEOS are also being pursued in Japan, Germany and France as well as other labs in the U.S. This paper summarizes experimental and theoretical work of the past four years and predictions of future capabilities and applications of the PEOS.

**7820 Some characteristics of the flux from the supermite flashboard.** Gray, E.W.; Stinnett, R.W. (Sandia National Labs., Albuquerque, NM 87185). pp 26 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract AC04-76DP00789.

Some aspects of plasma opening switch flashboards are examined experimentally. Ion velocities ≈ 8 x 10/sup 6/ cm/s are observed with flux measurements in the range 10-60 A/cm/sup 2/. The effect of a 80% transparent screen placed between the flashboard and the Magnetically-Insulated Transmission Line (MITL) on the ion velocity and flux is examined. The velocity was unaffected, whereas the flux was reduced considerably. Ion velocity and flux were also examined in terms of the flashboard driving potential in the range 25-40 kilovolts. The driving force behind fast ion velocities (≈10/sup 7/ cm/s) from flashboards for plasma opening switches is examined.

**7821 A solid discharge ion source for heavy ion fusion.** Kiuttu, G.F.; Adler, R.J.; Brown, R.D. (Mission Research Corp., 1720 Randolph Road, SE, Albuquerque, NM 87106). pp 14 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

One of the technical difficulties which must be solved before Heavy Ion Fusion (HIF) can become a commercially viable concept is the development of high brightness ion sources. Zeolite or vapor spark sources are capable of producing tens of milliamperes per square centimeter of heavy ion current with emittances of roughly 10/sup -4/ πR-cm. It is generally thought that a normalized brightness (B/sub n/ = I/ϵ/sub n//sup 2/, ϵ/sub n/ = βγϵ) of order 10/sup 8/ - 10/sup 10/ A/(Sr-cm)/sup 2/ for at least one microsecond will be required for HIF applications. The solid discharge source described here is a plasma source with current densities of order one ampere per square centimeter. The source is an outgrowth of the author's work with cloth fiber array cathodes. It was found that the useful pulse length of these cathodes was at least twice as long as that for conventional cold cathodes (due to reduced plasma expansion velocity), uniformity was improved, and in the case of one accelerator, beam brightness was increased over an order of magnitude, with long (>10/sup 5/ pulse) lifetimes. The improved performance of these cathodes may be attributed to the large number of field enhancement points and capacitive ballasting due to the nonconducting nature of the fibers.

**7822 Development of the boil off lithium vapor source (BOLVAPS) for a PBFA-II lithium ion source.** Dreike, P.L.; Tisone, G.C.; Carroll, D.W. (Sandia National Labs., Albuquerque, NM 87185). pp 30 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract AC04-76DP00789.

A thin layer of dense lithium plasma may be used for the ion source in intense ion beam diodes such as the one being developed for inertial confinement fusion experiments with the PBFA-II accelerator. Production of a thin vapor layer might be the first step in providing the plasma. Production of a lithium vapor layer by rapid evaporation and its ionization have been described. In these experiments, lithium was evaporated, by rapid (several μs) ohmic heating, from a 1 μm thick layer of LiAg alloy deposited on a 25 μm thick Ta foil. The vapor density was limited to ≈ 1 x 10/sup 16/ cm/sup -3/ in these experiments by termination of the heating pulse which arced through the evolving vapor. The thickness of the layer (a few mm) was determined by the heating pulse duration. A somewhat denser and thinner plasma layer is desired for the PBFA-II applied-B diode. To use this technique in a diode, the heater and

lithium layer must both be thin-films in a low inductance configuration. The authors are now performing an experiment using a submicrosecond duration fast heating pulse to test lithium evaporation from a coaxial structure composed of a molybdenum core, an alumina-titania insulator overcoated with a 10 μm thick tungsten heater layer, and 1 μm thick LiAg lithium reservoir. The geometry of the electrical circuit is topologically the same as one required for the PBFA-II diode. They are also designing a BOLVAPS source for use with the PBFA-II diode. Progress in the fast-pulsed experiment and the design for PBFA-II are presented.

7823 **Generation of a lithium plasma for large area ion diodes.** Tisone, G.C.; Rice, J.K.; Dreike, P.L. (Sandia National Labs., Albuquerque, NM 87185). pp 31 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986).

The selection of lithium ions for use in the PBFA II accelerator has made the development of a suitable ion source a high priority in Sandia's light ion beam fusion program. One concept that is currently being implemented is the BOLVAIS/LIBORS scheme. The BOLVAPS ( boil off lithium vapor source) produces a thin layer of lithium vapor on the anode surface of an ion diode by rapid ohmic heating of a thin film structure containing a lithium alloy. This vapor layer can be ionized efficently by LIBORS (laser ionization based on resonant saturation), using a dye laser tuned to the 670.8 nm resonance line of lithium. Briefly, the lithium is ionized in the following way. Ground state and first excited state lithium populations are brought into equilibrium with the incident light flux from the laser. A few electrons are produced by multiphoton processes, and heated by superelastic collisions with excited lithium atoms. These hot electrons then impact ionize excited state lithium. Over a period of several hundred nanoseconds, avalanche-like ionization takes place. At Sandia there has been a continuing program of laboratory measurements and computer modeling of this ionization process in lithium to develop the capability to model sources for ion diodes. measurements of the time for the ionization region to propagate through a 10 cm column of lithium vapor have been made and compared with the model. The BOLVAPS/LIBORS technique for the generation of a lithium plasma has been demonstrated in a small scale laboratory experiment. Results of these experiments are presented.

7824 **Microparticle-initiated losses in magnetically insulated transmission lines.** Gray, E.W.; Stinnett, R.W. (Sandia National Labs., Albuquerque, NM 87185). pp 36 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract AC04-76DP00789.

The author's discuss the effects of high and hypervelocity microparticles in magnetically-insulated transmission lines (MITLs) and how they may be a possible source for ion production near the anode in early stages of the voltage pulse, and current carriers during and after the power pulse, resulting in power flow losses. Early losses in the voltage pulse, due to microparticles, are estimated to be approximately 0.3 mA/cm/sup 2/. Blistering of the electrode surface, thought to be due to H/sup -/ bombardment, was also observed and appears to be consistent with losses due to negative ions previously reported by one of the authors.

7825 **Large-area liquid-lithium ion source for inertial confinement fusion.** Pregenzer, A.L.; Gerber, R.A.; Bieg, K.W.; Cianciabella, C.J. (Sandia National Labs., Albuquerque, NM 87185). pp 31 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). Contract AC04-76DP00789.

At present, the primary effort at Sandia is directed toward the development of a wetting technique that can be used in the fabrication of a lithium wetted anode for experiments on PBFA II. Several schemes are being pursued. The most promising is a method which involves wicking of the liquid lithium into a porous metal. The liquid comes to surface through a series of pores and wets the surface of the metal substrate. Two other schemes are evaporation of lithium onto a suitable metal substrate, with subsequent melting, and a liquid lithium injection method. These efforts and the metallurgical problems which are encountered are described. Results of relevant diode experiments are discussed. Low-voltage studies of surface dynamics are also included.

7826 **Plasma-filled applied-B diode.** Burns, E.J.T.; Bieg, K.W.; Woodworth, J.P.; Jaramillo, W. (Sandia National Labs.). pp 33 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

The authors have found that vacuum sparks, which are excellent sources of intense XUV, are also sources of late time plasma. This plasma has been used as an external ion source for a magnetically insulated ion diode on the 0.03TW Nereus accelerator. The diode and the external plasma XUV radiation source is shown. The external plasma is born from the surface flashover between copper electrodes across the insulator. This recombining plasma expands against the magnetic field created from the return current path in front of the insulator surface and the diode 1 Tesla radial magnetic field. Most of the data has been obtained with polyimide insulators in the plasma source. The axial component of velocity of the plasma toward the diode is 10 cm/ μs. The primary source of the plasma is adsorbates on the surface of the polyimide insulator. When necessary, the authors have used an argon/oxygen RF glow discharge to minimize the adsorbates. Most of the plasma is emitted non-normal to the surface or the insulator. Unbiased charge collector measurements without an accelerator pulse suggest the density of the ion component of the weakly ionized plasma is less than 5x10/sup chemical bondchemical bond/11 ions/cm3. On diode experiments, ion currents of 500 amps/cm2 have been generated with a plasma filled diode using a polyimide insulator. However, the uniformity of the plasma fill is poor. The ion fluence is 5x10/sup chemical bondchemical bond/13 ions/cm/sup chemical bondchemical bond/2 as measured by charge collectors on diode experiments. The ion efficiency of such a diode is poor, typically 25%.

7827 **High Z laser plasma experiments.** Kauffman, R.L. (Lawrence Livermore National Lab., Livermore, CA 94550). pp 62 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Understanding the coupling of high powered lasers to dense plasmas is a first step toward the realization of laser driven fusion. At LLNL there is a continuing effort to understand the coupling of short wavelength lasers to high Z plasmas. The intensity and wavelength dependence of absorption, energy partition and instability thresholds have been studied in order to develop a good predictive capability for high Z laser-produced plasmas. These studies, begun on Argus, Shiva and Novette, and most recently continued on the Nova laser facility, have extended the wavelength scaling studies from 1.06 to 0.26 μm wavelength using frequency multiplication techniques to convert the fundamental 1.06 μm wavelength of our Nd-glass lasers to shorter wavelengths. In general, shorter wavelength light couples more efficiently to the plasma with absorption measured as greater than 80% for 0.53 μm wavelength and 90% for 0.35 μm wavelength at intensities up to 10/sup 15/ W/cm/sup 2/. For high Z plasmas significant laser energy is converted to low energy x rays. In this paper, the author gives a brief overview of Nova, the present experimental facility, and its diagnostic capability. The author then presents highlights of the experiments and present understanding of high Z interaction experiments.

7828 **KrF laser-matter interaction in the long pulse, low intensity regime.** Gitomer, S.J.; Goldman, S.R.; Kopp, R.A.; Delamater, N.D.; Norton, J. (Univ. of California, Los Alamos National Lab., Los Alamos, NM 87545). pp 62 of Conference record of the 1986 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1986). (CONF-860523—).

From 13. IEEE international conference on plasma science; Saskatoon, Saskatchewan, Canada (19 May 1986).

Comparisons are made between experiment and simulation of imparted momentum, target mass loss, blowoff electron density and emission spectrum. The authors find that the incident laser light

may be nearly completely absorbed in the blowoff plasma away from the ablation surface and it is the reradiated x-rays or electron thermal conduction which drive the target surface ablation. The calculated fluid quantities of velocity and mass density appear to behave self-similarly. The functional form of this behavior is, however, more complicated than the familiar adiabatic or isothermal rarefaction forms widely used in analytic modeling. 20 effects are found to become important at sufficiently high fluence levels, above about 10/sup 4/ Joules/ cm/sup 2/.

7829 **Performance characteristics of a 26- x 26-cm aperture Pockels cell using plasma electrodes.** Goldhar, J.; Henesian, M.A. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 142 of Conference record of the 1985 IEEE conference on lasers and electro-optics. Piscataway, NJ; IEEE Service Center (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The concept of a longitudinal electrooptical switch utilizing plasma electrodes was recently scaled-up to the 26- X 26-cm aperture using a 1-cm thick KDP crystal. This device has an order of magnitude larger open area and a factor of ≈30 higher crystal aspect ratio than Pockels cells of the conventional ring-electrode design. Optical switching speeds of better than 30 nsec over the entire aperture have been achieved. The plasma electrode design is scalable to larger apertures (≧ 1 m) and is potentially of great importance for future development of high-energy laser drivers for inertial confinement fusion. The electrical and optical characteristics of the 26- X 26-cm Pockels cell are being investigated for several different driver configurations and operating conditions.

# 99 GENERAL AND MISCELLANEOUS

7830 **(EGG—10282-2122) Intrapopulational variation of cranial measurements in the San Joaquin kit fox, Naval Petroleum Reserve No. 1, Kern County, California.** Dragoo, J.W.; Choate, J.R.; O'Farrell, T.P. (Fort Hays State Univ., Hays, KS (USA). Museum of the High Plains; EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations). Aug 1986. Contract AC08-83NV10282. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002375.

Intrapopulational variation was assessed using 14 cranial measurements in 205 specimens of the San Joaquin kit fox (Vulpes macrotis mutica). Results of variance components analysis revealed little secondary sexual variation relative to variation with age or individual variation. Results of both Tukey's studentized range test and principal components analysis showed that cranial measurements of subadult and adult males and females could be pooled for taxonomic study of geographic variation of these foxes. Skulls of old adults were significantly larger than subadults and adults and were analyzed separately. Measurements of puppies were extremely variable and were not useful for taxonomic analysis.

7831 **(SAND—86-1404-Vol.10-No.1) Sandia Technology. Volume 10, No. 1.** Thornbrough, A.D.; Butcher, B.M.; Calek, J.F.; Merritt, M.L.; Mead, P.L. (eds.). (Sandia National Labs., Albuquerque, NM (USA)). Oct 1986. Contract AC04-76DP00789. 25p. NTIS, PC A02/MF A01. File Number DE87001846.

Two articles are included, which are abstracted separately: strained-layer superlattices, and heat transfer in solid-particle solar receivers. Lawrence awards and technology transfer are also covered. (DLC)

## 9901 Management

7832 **(AD-A—171585/3/XAB) High-temperature temporal stability of selected oxidizers as solids and in aqueous solutions. Interim report.** Pellenbarg, R.E.; Smiroldo. (Naval Research Lab., Washington, DC (USA)). 8 Aug 1986. 15p. (NRL-MR—5824). NTIS, PC A02/MF A01.

Various potential decontamination agents were examined as solids and in aqueous solutions for long-term stability at high temperatures. The following oxidizers were assayed iodometrically: the hypochlorite salts of calcium and lithium, sodium dischloroisocyanurate (PACE) and the preoxygen compounds sodium perborate, sodium peroxydisulfate, sodium percarbonate, and magnesium monoperoxyphthalate (H-48). The inorganic peroxide solids and the solid sodium dischloroisoyanurate were stable at 80 C, while the organic peroxide solids and the hypochlorite salts deteriorated markedly within 72 hours. In freshwater solutions of 0.01 N or less, the inorganic hypochlorite and peroxide salts decomposed slowly at 60 c. Conversely, the sodium dischloroisocyanurate, magnesium monoperoxyphthalate, and sodium percarbonate solutions exhibited near complete decomposition in 24 hours.

7833 **(AD-A—171995/4/XAB) Land-based air in a national maritime strategy: the need for a joint strategic doctrine. Final report.** Staley, R.S. (Naval War Coll., Newport, RI (USA)). 30 May 1986. 71p. (NWC/ARP—86-24). NTIS, PC A04/MF A01.

This paper examines the role of land-based air power within a national maritime strategy. Corbett taught that naval strategy is a subsidiary aspect of a national maritime strategy; and the increasing speed, range, and accuracy of aircraft, weapons, detection, and communications ensure that an important part of maritime air control will be land-based. To evaluate that claim, this paper examines the unity of sea control and air control; examines the Air Force missions that affect sea control; discusses the strategic concerns directing land-based air in maritime strategy; and explains why joint strategic doctrine will better integrate our military forces.

## 9902 Mathematics And Computers

*REFER ALSO TO CITATION(S) 6776, 6790, 7650, 7656*

7834 **(AD-A—171505/1/XAB) Nonsequential computation and laws of nature. Interim report.** Vitanyi, P.M. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Computer Science). May 1986. 22p. (MIT/LCS/TM—306). NTIS, PC A02/MF A01.

Traditionally, computational complexity theory deals with sequential computations. In the computational models, the underlying physics is hardly accounted for. This attitude has persisted in common models for parallel computations - wrongly, the author argues, since the laws of physics intrude forcefully when we want to obtain realistic estimates of the performance of parallel or distributed algorithms. First, he explains why it is reasonable to abstract away from the physical details in sequential computations. Second, he shows why certain common approaches in the theory of parallel complexity do not give useful information about the actual complexity of the parallel computation. Third, he gives some examples of the interplay between physical considerations and actual complexity of distributed computations.

7835 **(AD-A—171546/5/XAB) Randomized routing on fat trees. Interim research report.** Greenberg, R.I.; Leiserson, C.E. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Computer Science). May 1986. 27p. (MIT/LCS/TM—307). NTIS, PC A03/MF A01.

Fat trees are a class of routing networks for hardware-efficient parallel computation. This paper presents a randomized algorithm for routing messages on a fat tree. The quality of the algorithm is measured in terms of the load factor of a set of messages to be routed, which is a lower bound on the time required to deliver the messages. This document shows that if a set of messages has load factor lambda on a fat tree with n processors, the number of delivery cycles (routing attempts) that the algorithm requires is O(lambda + lg n lg lg n) with probability 1-O(1/n). The best previous bound was O(lambda lg n) for the off-line problem where switch settings can be determined in advance. In a VLSI-like model where hardware cost is equated with physical volume, the routing algorithm demonstrates that fat trees are universal routing networks in the sense that any routing network can be efficiently simulated by a fat tree of comparable hardware cost.

7836 **(AD-A—171561/4/XAB) Programming environment for parallel-vision algorithms. Annual report, February 1985-February 1986.** Brown. (Rochester Univ., NY (USA). Dept. of Computer Science). Aug 1986. 25p. NTIS, PC A02/MF A01.

During the first year of the award period, three main lines of work were pursued: systems support algorithms, Butterfly programming environment, and vision applications. Today's multiprocessor computer architectures are not efficiently programmed or even conceptualized with standard computer languages, and their operating systems and debugging tools are also challengingly different. The University of Rochester is doing work in the area of tools for controlling large-grain parallelism, as one finds in a distributed multiprocessor application like the Autonomous Land Vehicle, or in tightly coupled processors like the Hypercube or the Butterfly Parallel Processor.

7837 **(AD-A—171686/9/XAB) Parallel first-order linear recurrence solver. Technical report.** Meyer, G.G.L.; Podrazik, L.J. (Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Electrical Engineering and Computer Science). Sep 1986. 29p. (JHU/EECS—86/07). NTIS, PC A03/MF A01.

This paper presents a parallel algorithm for the solution of first-order linear recurrence systems of size N when the number of processors p is small in relation to N.

7838 **(AD-A—171898/0/XAB) Block-oriented, local-memory linear equation solution on the Cray-2. Part 1. Uniprocessor algorithms. Interim report.** Calahan, D.A. (Michigan Univ., Ann Arbor (USA). Supercomputer Algorithm Research Lab.). 15 Dec 1985. 32p. (SARL—9). NTIS, PC A03/MF A01.

From 2. SIAM Conference on Scientific & Parallel Computing; Norfolk, VA, USA (18 Nov 1985).

Experience with the CRAY-2 on the effects of common memory speed and loading-on performance indicate that local-memory-based algorithms have potentially a large advantage. The performance of a number of common- and local-memory algorithms are compared for the LU factorization of a dense systems of equations on the CRAY-2. Results of both Fortran- and assembly language implementations are given.

7839 **(AD-A—172041/6/XAB) Simulation of an ultracomputer with several hot spots. Technical report.** Rosenblum, D.S.; Mayr, E.W. (Stanford Univ., CA (USA). Dept. of Computer Science). Jun 1986. 37p. (STAN-CS—86-1119). NTIS, PC A03/MF A01.

This report describes the design and results of a time-driven simulation of an ultracomputer-like multiprocessor in the presence of several hot spots, or memory modules, which are frequent targets of requests. Such hot spots exist during execution of parallel programs in which the several threads of control synchronize through manipulation of a small number of shared variables. The simulated system is comprised of N processing elements (PEs) and N shared memory modules connected by an N x N buffered, packet-switched Omega network. The simulator was designed to accept a wide variety of system configurations to enable observation of many different characteristics of the system behavior. Results are presented of four experiments: (1) General simulation of several 16-PE configurations, (2) General simulation of several 512-PE configurations, (3) Determination of critical queue lengths as a function of request rate (512 PEs), and (4) Determination of the effect of hot-spot spacing on system performance (512 PEs).

7840 **(AD-A—172043/2/XAB) Applications of parallel scheduling to perfect graphs. Technical report.** Helmbold; Mayr, E.W. (Stanford Univ., CA (USA). Dept. of Computer Science). Jun 1986. 19p. (STAN-CS—86-1118). NTIS, PC A02/MF A01.

The authors combine a parallel algorithm for the two processor-scheduling problem, which runs in polylog time on a polynomial number of processors, with an algorithm to find transitive orientations of graphs where they exist. Both algorithms together solve the maximum-clique problem and the maximum-coloring problem for co-comparability graphs. These parallel algorithms can also be used to identify permutation graphs and interval graphs, important subclasses of perfect graphs.

7841 **(ANL—7416-Suppl.3-Add.) National Energy Software Center: Benchmark problem book.** (Argonne National Lab., IL (USA)). Dec 1985. Contract W-31-109-ENG-38. 246p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87000539.

7842 **(BNL—38716) Kriging and its relation to least squares.** Oden, N. (Brookhaven National Lab., Upton, NY (USA)). Nov 1984. Contract AC02-76CH00016. 47p. NTIS, PC A03. File Number DE87002142.

Kriging is a technique for producing contour maps that, under certain conditions, are optimal in a mean squared error sense. The relation of Kriging to Least Squares is reviewed here. New methods for analyzing residuals are suggsted, ML estimators inspected, and an expression derived for calculating cross-validation error. An example using ground water data is provided.

7843 **(CWI-CS—R8515) Operational semantics of a parallel object-oriented language.** America, P.; Debakker, J.; Kok, J.N.; Rutten, J. (Stichting Mathematisch Centrum, Amsterdam (Netherlands)). Aug 1985. 22p. NTIS, PC A02/MF A01.

The semantics of the programming language POOL is described. The language integrates the object-oriented structure of languages like Smalltalk-80 with facilities for concurrency and communication like the ones in Ada. The semantics is described in an operational way: it is based on transition systems. By using a way of representing parallel processes that is different from the traditional one, it is possible to overcome difficulties pertaining to the latter. The resulting semantics shows a close resemblance with the informal language description, and there are good prospects that it can serve as a secure guide for the implementation of the language.

7844 **(DOE/ER/25001—12) Multiprocessor Jacobi algorithms for dense symmetric eigenvalue and singular value decompositions.** Berry, M.; Sameh, A. (Illinois Univ., Urbana (USA). Center for Supercomputing Research and Development). 19 Feb 1986. Contract FG02-85ER25001. 41p. (CONF-860877—2; CSRD—546). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002102.

From International conference on parallel processing; St. Charles, IL, USA (19 Aug 1986).

Two parallel algorithms are presented based on Jacobi's method for real symmetric matrices to determine the complete eigensystem of a dense real symmetric matrix and the singular value decomposition of rectangular matrices on a multiprocessor. The intent is to study the advantages of using Jacobi and Jacobi-like schemes over new and existing EISPACK and LINPACK routines on an Alliant FX/8 computer system. For the dense symmetric eigenvalue problem, promising results are shown for small-order matrices. A "one-sided" Jacobi-like algorithm which produces the singular value decomposition of a rectangular matrix is shown to provide superior performance for rectangular matrices in which the number of rows is much larger than the number of columns. 17 refs., 9 figs., 5 tabs.

7845 **(DOE/ER/25001—18) Vector processing on the Alliant FX/8 multiprocessor.** Abu-Sufah, W.; Malony, A.D. (Illinois Univ., Urbana (USA). Center for Supercomputing Research and Development). 1986. Contract FG02-85ER25001. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87002098.

The Alliant FX/8 multiprocessor implements several high-speed computation ideas in software and hardware. Each of the 8 computational elements (CEs) has vector capabilities and multiprocessor support. Generally, the FX/8 delivers its highest processing rates when executing vector loops concurrently. In this paper, extensive empirical performance results are presented for vector processing on the FX/8. The vector kernels of the LANL BMK8al benchmark are used in the experiments. Each kernel is executed on 1 and 8 CEs and show the measured execution rate (in MFLOPS) as a function of vector length. The performance of 1 CE as a

vector processor is analyzed by finding the vector lengths where vector processing exceeds that of scalar processing and calculating Hockney's n/sub 1/2/. For 8 CEs, upper/lower bounds are given on the achieved speedups and on the multiprocessing overhead. The speedup variation is shown as the number of CEs increases from 2 to 8. 25 refs., 8 figs., 7 tabs.

7846 **(N—86-26992) Design and implementation of cost-effective algorithms for direct solution of banded linear systems on the vector processor system 32 supercomputer.** Samba, A.S. (Hampton Inst., VA (USA)). 1985. 48p. (NASA-CR—17681). NTIS, PC A03/MF A01.

The problem of solving banded linear systems by direct (non-iterative) techniques on the Vector Processor System (VPS) 32 supercomputer is considered. Two efficient direct methods for solving banded linear systems on the VPS 32 are described. The vector cyclic reduction (VCR) algorithm is discussed in detail. The performance of the VCR on a three parameter model problem is also illustrated. The VCR is an adaptation of the conventional point cyclic reduction algorithm. The second direct method is the Customized Reduction of Augmented Triangles' (CRAT). CRAT has the dominant characteristics of an efficient VPS 32 algorithm. CRAT is tailored to the pipeline architecture of the VPS 32 and as a consequence the algorithm is implicitly vectorizable.

7847 **(N—86-28651) Hardware configuration for a real-time multiprocessor simulator.** Blech, R.A.; Williams, A.D. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jul 1986. 21p. (NASA-TM—88802; E—3141; NAS—1.15:88802). NTIS, PC A02/MF A01.

The Real-Time Multiprocessor Simulator (RTMPS) is a multiple microcomputer system used to investigate the application of parallel-processing concepts to real-time simulation. This users manual describes the set-up and installation considerations for the RTMPS hardware. Any modifications or further improvements to the RTMPS hardware will be documented in an addendum to this manual.

7848 **(N—86-30380) Force on the flex: global parallelism and portability. Final report.** Jordan, H.F. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Aug 1986. 22p. (NASA-CR—178161; ICASE—86-54; NAS—1.26:178161). NTIS, PC A02/MF A01.

A parallel programming methodology, called the force, supports the construction of programs to be executed in parallel by an unspecified, but potentially large, number of processes. The methodology was originally developed on a pipelined, shared memory multiprocessor, the Denelcor HEP, and embodies the primitive operations of the force in a set of macros which expand into multiprocessor Fortran code. A small set of primitives is sufficient to write large parallel programs, and the system has been used to produce 10,000 line programs in computational fluid dynamics. The level of complexity of the force primitives is intermediate. It is high enough to mask detailed architectural differences between multiprocessors but low enough to give the user control over performance. The system is being ported to a medium scale multiprocessor, the Flex/32, which is a 20 processor system with a mixture of shared and local memory. Memory organization and the type of processor synchronization supported by the hardware on the two machines lead to some differences in efficient implementations of the force primitives, but the user interface remains the same. An initial implementation was done by retargeting the macros to Flexible Computer Corporation's ConCurrent C language. Subsequently, the macros were caused to directly produce the system calls which form the basis for ConCurrent C. The implementation of the Fortran based system is in step with Flexible Computer Corporations's implementation of a Fortran system in the parallel environment.

7849 **(N—86-30425) Substructuring algorithms and solution techniques for the numerical approximation of partial differential equations.** Gunzburger, M.D.; Nicolaides, R.A. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). May 1986. 32p. (NASA-CR—178122; ICASE—86-30; NAS—1.26:178122). NTIS, PC A03/MF A01.

Substructuring methods are in common use in mechanics problems where typically the associated linear systems of algebraic equations are positive definite. These methods are extended to problems which lead to nonpositive definite, nonsymmetric matrices. The extension is based on an algorithm which carries out the block Gauss elimination procedure without the need for interchanges even when a pivot matrix is singular. Examples are provided wherein the method is used in connection with finite element solutions of the stationary Stokes equations and the Helmholtz equation, and dual methods for second-order elliptic equations.

7850 **(PB—86-242112/XAB) Propagation of boundary effects in large systems on vector processors.** Hoek, J. (Rutherford Appleton Lab., Chilton (UK)). 1986. 16p. (RAL—86-031). NTIS, PC PC E03/MF E03.

The treatment of a problem in which the total set of data is too large to fit into memory and the data sets far away from the boundary are too small to get a satisfactory vector length is described. The particular problem is one in lattice gauge theory, studying the influence of boundary conditions of a 4-dimensional lattice on plaquettes in the interior. Most of the techniques can be generalized.

7851 **(PB—86-245685/XAB) Some problems of exploiting a pipeline processor (revised).** Modi, J.J.; Rollett, J.S. (Cambridge Univ. (UK). Dept. of Engineering). 1986. 7p. (CUED-F-CAMS-TR—240-REV). NTIS, PC PC E04/MF E04.

A number of ways in which the design of the AP-120B processor is unbalanced against fixed-point operations are displayed. The full power of its floating-point processing cannot be realized in contexts in which many vectors need to be handled together. This implies that the power/cost ratio of the machine is less favorable than it could have been. Bottlenecks in the highways of the machine are also displayed that worsen the situation.

7852 **(RAL—85-036) Finite element analysis using a single-user computer.** Colyer, B.; Trowbridge, C.W. (Rutherford Appleton Lab., Chilton (UK)). May 1985. 15p. Rutherford Appleton Lab., Chilton Didcot Oxon OX11 OQX. File Number TI87900165.

A two dimensional finite element program has been translated from Pascal to Fortran to run on an ICL PERQ Single User Computer under the PNX Operating System. Many improvements and extensions have been incorporated, including automatic meshing algorithms. Extensive use is made of the PERQ's excellent interactive graphics capabilities to set up models, boundary conditions, etc, and to post-process the results. 4 refs., 5 figs.

7853 **(SAND—86-1693C) Portable system for simulating distributed parallel processors on shared memory machines.** Montry, G.R. (Sandia National Labs., Albuquerque, NM (USA). Fluid and Thermal Sciences Dept.). Sep 1986. Contract AC04-76DP00789. 10p. (CONF-8609173—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000449.

From 2. conference on hypercube multiprocessors; Knoxville, TN, USA (29 Sep 1986).

A package of FORTRAN communications routines has been developed for use on shared memory multiprocessors. The package allows users to define an arbitrary processor interconnect scheme as though they were working on a distributed memory machine. Data which are not shared between processes or processors may be exchanged via a shared pool of circular buffers. The data messages are physically copied from the sending processor to the receiving processor via the buffers. The package is portable among shared memory architectures. The only system-dependent capabilities necessary to implement the package are: (1) a method of sharing some common memory between all processors; (2) a method of implementing critical sections of shared code, such as locks; and (3) a method of synchronizing tasks, such as semaphores. The package supports two types of processor-processor communications. The synchronous method, in which cooperating processes must rendezvous in order to exchange data, can be invoked with a single switch. The default method is asynchronous; in which the sending

process continues computation without synchronizing with the receiving processor. 5 refs., 3 figs.

7854 **(UCRL—95277) Integration of communications with the Intelligent Gateway Processor.** Hampel, V.E. (Lawrence Livermore National Lab., CA (USA)). 1986. Contract W-7405-ENG-48. 19p. (CONF-8608110—2). NTIS MF A01; 2; GPO Dep. File Number DE87002386.

From Seminar on integrated power plant computer communications; San Francisco, CA, USA (25 Aug 1986).

The Intelligent Gateway Processor (IGP) software is being used to interconnect users equipped with different personal computers and ASCII terminals to mainframe machines of different make. This integration is made possible by the IGP's unique user interface and networking software. Prototype systems of the table-driven, interpreter-based IGP have been adapted to very different programmatic requirements and have demonstrated substantial increases in end-user productivity. Procedures previously requiring days can now be carried out in minutes. The IGP software has been under development by the Technology Information Systems (TIS) program at Lawrence Livermore National Laboratory (LLNL) since 1975 and is in use by several federal agencies since 1983: The Air Force is prototyping applications which range from automated identification of spare parts for aircraft to office automation and the controlled storage and distribution of technical orders and engineering drawings. Other applications of the IGP are the Information Management System (IMS) for aviation statistics in the Federal Aviation Administration (FAA), the Nuclear Criticality Information System (NCIS) and a nationwide Cost Estimating System (CES) in the Department of Energy, the library automation network of the Defense Technical Information Center (DTIC), and the modernization program in the Office of the Secretary of Defense (OSD). 31 refs., 9 figs.

7855 **Numerical techniques for ordinary differential equations.** Hindmarsh, A.C. (Lawrence Livermore National Lab., CA, USA). *Particle Accelerators;* **19**: No. 1-4, 67-71(1986). (CONF-8503105—).

From Orbital dynamics and applications to accelerators workshop; Berkeley, CA, USA (7 Mar 1985).

General numerical methods for ordinary differential equations (ODE) initial-value problems are surveyed, with emphasis on second-order ODE's. Issues include truncation and roundoff error, stability, and starting/stopping. For nonstiff systems, predictor-corrector Adams methods, with variable step and order, are best overall.

7856 **Distributed computer control systems.** Suski, G.J. Elmsford, NY; Pergamon Press (1986). 300p. Pergamon Press, Fairview Park, Elmsford, NY 10523.

This book focuses on recent advances in the theory, applications and techniques for distributed computer control systems. Contents (partial): Real-time distributed computer control in a flexible manufacturing system. Semantics and implementation problems of channels in a DCCS specification. Broadcast protocols in distributed computer control systems. Design considerations of distributed control architecture for a thermal power plant. The conic toolset for building distributed systems. Network management issues in distributed control systems. Interprocessor communication system architecture in a distributed control system environment. Uni-level homogenous distributed computer control system and optimal system design. A-nets for DCCS design. A methodology for the specification and design of fault tolerant real time systems. An integrated computer control system - architecture design, engineering methodology and practical experience.

7857 **Harnessing computational power: Distributed combinator evaluation.** Michelsen, R.E.; Fasel, J.H. (Univ. of California, Los Alamos National Lab., Los Alamos, NM). pp 107-111 of New computing environments:Parallel, vector and systolic. Wouk, A. Philadelphia, PA; Society for Industrial and Applied Mathematics (1986). (CONF-8411140—).

From ARO workshop on new computing environments: parallel, vector and systolic; Stanford, CA, USA (7 Nov 1984).

Much interest has been generated by the notion of combinator graph reduction as a mechanism for the implementation of functional languages. An effort is currently in progress at Los Alamos National Laboratory, in collaboration with Yale University, to develop a testbed distributed implementation of a functional language based on this concept. The overall goal is to facilitate the exploitation of implicit parallelism; within this framework, the authors intend to use this testbed to evaluate the utility of strategies for combinator graph reduction in a distributed computing system.

7858 **Performance and library issues for mathematical software on high performance computers.** Dongarra, J.J.; Sorensen, D.C. (Argonne National Lab., Argonne, IL). pp 112-135 of New computing environments:Parallel, vector and systolic. Wouk, A. Philadelphia, PA; Society for Industrial and Applied Mathematics (1986). (CONF-8411140—).

From ARO workshop on new computing environments: parallel, vector and systolic; Stanford, CA, USA (7 Nov 1984).

This paper discusses some of the fundamental issues facing designers of mathematical software libraries for medium scale parallel processors such as the CRAY X-MP-4 and the Denelcor HEP. The authors discuss the problems that arise with performance and demonstrate that it may be appropriate to exploit parallelism at all levels of the program, not just at the highest level. They give performance measurements indicating the efficiency of a linear algebra library written in terms of a few high level modules. These modules chosen at the matrix vector level extend the concept of the BLAS and provide enough computational granularity to allow efficient implementations on a wide variety of architectures. Only three modules must be recoded for efficiency in order to transport the library to various machines. The authors report experience on machines as diverse as the CRAY X-MP and the Denelcor HEP. Finally, they report on some special algorithms for the HEP which take advantage of the fine grain parallelism capabilities.

7859 **Parallel computation of multiple-scale problem.** Chin, R.C.; Hedstrom, G.W.; Howes, F.A.; McGraw, J.R. (Lawrence Livermore National Lab., P.O. Box 808, Livermore, CA). pp 136-153 of New computing environments:Parallel, vector and systolic. Wouk, A. Philadelphia, PA; Society for Industrial and Applied Mathematics (1986). (CONF-8411140—).

From ARO workshop on new computing environments: parallel, vector and systolic; Stanford, CA, USA (7 Nov 1984).

The efficient use of multiprocessor computers requires the introduction of new numerical algorithms, and the identification by asymptotic analysis of concurrencies inherent in the governing equations of multiple-scale problems is a good way to develop such algorithms. The language used must be able to maintain these concurrencies. Finally, depending on the problem and the computer, this concurrency may not be sufficient to keep all the processors busy, so that the language must be able to identify additional concurrencies. These ideas are illustrated in an example based on a convection-diffusion equation.

7860 **Parallel algorithms for elliptic equations.** McBryan, O.A.; Van de Velde, E.F. (Courant Institute, 251 Mercer St., New York, NY). pp 234-270 of New computing environments:Parallel, vector and systolic. Wouk, A. Philadelphia, PA; Society for Industrial and Applied Mathematics (1986). (CONF-8411140—).

From ARO workshop on new computing environments: parallel, vector and systolic; Stanford, CA, USA (7 Nov 1984).

The authors describe a number of parallel algorithms for the numerical solution of elliptic equations and present some implementations on the Denelcor HEP Parallel Processor. The authors use a tree of increasingly fine grids to achieve parallelism in the coarse of mesh refinement. They use conjugate gradient methods as well as multigrid methods to solve the resulting algebraic equations within each subgrid. The authors describe the implementation of these methods as parallel algorithms, and present results of actual performance on the HEP computer. In each case, they demonstrate near optimal performance on the HEP, as measured by speedup over the corresponding serial algorithm.

7861 **Characterizing the parallelism in rule-based expert systems.** Douglass, R.J. (Computer User Services, C-10, MS B296, Los Alamos National Lab., Los Alamos, NM 87545). pp 47-54 of Proceedings of the eighteenth Hawaii international conference on system sciences. Volume 2. Shriver, B.D. Honolulu, HI; Hawaii International Conference on System Sciences (1985). (CONF-850131—).

From International conference on systems science; Honolulu, HI, USA (1 Jan 1985).

A review of two classes of rule-based expert systems is presented, followed by an analysis of potential sources of parallelism at the production or rule level, the subrule level (including match, select, and act parallelism), and at the search level (including 'AND,' 'OR,' and stream parallelism). The potential amount of parallelism from each source is discussed and characterized in terms of its granularity.

## 9903 Information Handling

7862 **(AGARD-CP—85) Value of information as an integral part of aerospace and defence R and D programmes.** (Advisory Group for Aerospace Research and Development, 92 - Neuilly-sur-Seine (France)). Jan 1986. 96p. (CONF-8509341—). NTIS, PC A05/MF A01.

From Conference on the value of information as an integral part of aerospace and defence R and D proprammes; Cheltenham, UK (4 Sep 1985).

The management and use of scientific and technical information in the R and D process is examined from the perspective of policy makers, program managers, and researchers. Aspects considered at the meeting included the need to incorporate information as an integral part of the R and D process, the value of information in reducing the cost and preventing the duplication of research, improvements in the sharing of information resources among the NATO countries, and requirements for the future.

7863 (AGARD-CP—85, pp vp) **Information resources management in the R and D environment.** Buerk, K. Jan 1986. NTIS, PC A05/MF A01. (CONF-8509341—).

From Conference on the value of information as an integral part of aerospace and defence R and D proprammes; Cheltenham, UK (4 Sep 1985).

Efficient management of highly specialized information is a permanent task of optimization, whereby framework conditions may constantly change on account of various influencing factors. Owing to their special significance, the following has to be considered in particular: user needs, available resources, and information techniques. The task of optimization, due to its complexity, cannot be solved model-like, but only approximately and pragmatically. Illustrated by the example of the Federal Republic of Germany and the Fachinformationszentrum Energie Physik Mathematik (FIZ) the attempt to find a practical solution is demonstrated. In this context it is shown which role a National Information Center plays within international and national cooperation including worksharing, and how information supply and dissemination of information works in the case of central information services by FIZ, and decentral dissemination of information in research centers. Illustrated by the examples of database production, online services of bibliographic, numeric and full-text databases and the concept of the International Information Network for Science and Technology (STN International), the importance of the use of the most modern information techiques is demonstrated.

7864 **(FIPS/PUB—104-1/XAB) American National Standard codes for the representation of names of countries, dependencies, and areas of special sovereignty for information interchange. Category: Data Standards and Guidelines. Subcategory: Representations and Codes. Federal Information Processing Standards (Final).** Saltman, R.G. (National Bureau of Standards, Washington, DC (USA)). 12 May 1986. 25p. NTIS, PC A02/MF A01.

Three ring vinyl FIPS binder also available, North American Continent price $6.25; all others write for quote.

The Federal Program Standard implements American National Standard ANSI Z39.27-1984, Structure for the Representation of Names of Countries, Dependencies, and Areas of Special Sovereignty for Information Interchange. ANSI Z39.27 adopts, with qualifications, the entities, names, and codes prescribed by ISO 3166-1981, Codes for the Representation of Names of Countries, a standard of the International Organization for Standardization (ISO). The qualifications provide for coverage of the total land area of the earth without overlap or duplication, and provide for entity names that, to the maximum extent possible, are approved or accepted by the U.S. Board on Geographic Names. Both two-character and three-character alphabetic codes are provided for each entity adopted from ISO 3166-1981. The two-character codes are adopted as the Federal Program Standard and they are recommended by ISO for international interchange. The three-character codes are available for special applications when their use would provide a particular advantage.

7865 **(GANIL—85-01) Audiovisual document. "Introduction to the visit of GANIL".** Pouthas, J.; Anazel, J.P. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). 1985. 17p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE87750254.

During the year 1985, an audiovisual document (diaporama) has been realized on GANIL. This diaporama with four slide-projectors, which lasts 12 minutes is permanently set in a conference room at GANIL. Two video sequences have been realized, coming from this diaporama, on experimentation in nuclear physics on the operation principle of the cyclotrons.

7866 **(Juel-Spez—354) Abbreviations used in scientific and technical reports.** Sun Chang. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralbibliothek). Apr 1986. 144p. NTIS (US Sales Only), PC A07/MF A01. File Number DE87750076.

Reports contain a large number of abbreviations which have not yet been included in the current specialized dictionaries or lists of abbreviations. It is therefore often time-consuming or even fruitless to search for such abbreviations. The present alphabetical list of more than 4,000 abbreviations gathered from the report inventory of the Central Library of the KFA Juelich in the period from 1982-1986, taking into consideration all the scientific and technical disciplines, is intended to remedy a deficiency and to offer assistance which will undoubtedly be welcomed by scientists and engineers.

7867 **(PNL-SA—14428) Patent search strategies and techniques: Concept paper.** Levine, L.O. (Pacific Northwest Lab., Richland, WA (USA)). Sep 1986. Contract AC06-76RL01830. 29p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87002470.

This paper reports some of the search techniques and strategies used for patent data-base searching. Patents are a unique source of technical information. One study found that 80% of the information disclosed in patents is not published anywhere else (Office of Technology Assessment and Forecasting, 1977). Proficiency in searching patent data bases is a useful research skill; we hope the information in this report will prove valuable. Those preparing to conduct significant search efforts should study appropriate data-base documentation or contact the data-base producer.

# CORPORATE AUTHOR INDEX

In the Corporate Author Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the document title and the volume and abstract numbers. The document type, e.g., R for Report; country of publication, e.g., US; and language of the document, e.g., In German, are given in parentheses at the end of the entry. If no language statement appears, the language is English. Tables of document types and country of publication codes appear after the indexes.

DOE Energy Data Base: Corporate Author Entries (DOE/TIC-4585) is used in the standardization of corporate entries. DOE/TIC-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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The subject index is based on the use of subject descriptors selected from a controlled thesaurus of terms (DOE/TIC-7000). Subject descriptors and qualifiers (subheadings) are selected and presented in the following format:

**SUBJECT DESCRIPTOR**
**Qualifier**
Title, (supplementary information), citation number, (R;US)

The notations in the final parentheses indicate the type of document, e.g., R for Report; the country of publication, e.g., US; and the language if other than English, e.g., In German. Tables of document types and country of publication codes appear after the indexes.

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept (e.g., Pipeline Quality Gas, see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.

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| | **S-Cubed, La Jolla, CA (USA)** | |
| | 12:7650 | UCRL—15852 |
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| 171546/ 5/ XAB | NTIS, PC A03/MF A01 | | | 12:7835 |
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| 38480 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE86015146 | MN -34D | 12:7201 |
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| 38716 | NTIS, PC A03; 3 | | DE87002142 | MN -11 | 12:7842 |
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| 4 | *See* CEA-CONF-8074 | DE87750238 | MN -21 | 12:7798 |
| CONF-8507137- | (Conference on non-perturbation methods, Montpellier, France, 9-13 Jul 1985) | | | |
| 1 | *See* CEA-CONF-8241 | DE87750255 | MN -34D | 12:7680 |
| CONF-8507139- | (Workshop on early crustal genesis: the world's oldest rocks, Godthab, Greenland, 21-30 Jul 1985) | | | |
| | *See* N-86-28535 | | | 12:7509 |
| CONF-8507140- | (International workshop on Antarctic meteorites, Mainz, F.R. Germany, 10-12 Jul 1985) | | | |
| | *See* N-86-28811 | | | 12:7532 |
| CONF-850809- | (8. international conference on structural mechanics in reactor technology, Brussels, Belgium, 19-23 Aug 1985) | | | |
| 83 | *See* FRADOC-5-7 | DE87750231 | MN -78 | 12:6658 |
| 84 | *See* CEA-CONF-8378 | DE87750283 | MN -11 | 12:7500 |
| CONF-850830- | (10. international colloquium on dynamics of explosions and reactive systems, Berkeley, CA, USA, 4-9 Aug 1985) | | | |
| 10 | *See* CEA-CONF-8377 | DE87750284 | MN -80 | 12:6686 |
| CONF-850883- | (19. international cosmic ray conference, La Jolla, CA, USA, 11-23 Aug 1985) | | | |
| Vol.9 | *See* N-86-31483 | | | 12:7567 |
| Vol.10 | *See* N-86-28904 | | | 12:7550 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| CONF-850887- | (SPIE international technical symposium on optical and electro-optical engineers, San Diego, CA, USA, 18-23 Aug 1985) | | | |
| | Sol. Energy Mater., 14: No. 3-5, 269-287(Nov 1986) | | | 12:6592 |
| | Sol. Energy Mater., 14: No. 3-5, 395-416(Nov 1986) | | | 12:6604 |
| | Sol. Energy Mater., 14: No. 3-5, 417-425(Nov 1986) | | | 12:6605 |
| | Sol. Energy Mater., 14: No. 3-5, 437-445(Nov 1986) | | | 12:6794 |
| | Sol. Energy Mater., 14: No. 3-5, 161-174(Nov 1986) | | | 12:6868 |
| | Sol. Energy Mater., 14: No. 3-5, 205-214(Nov 1986) | | | 12:6869 |
| CONF-850918- | (International topical meeting on high level nuclear waste disposal - technology and engineering, Pasco, WA, USA, 24-26 Sep 1985) | | | |
| 16 | *See* HEDL-SA-3296-FP | E 1.99: DE87000187 | MN -70 | 12:6827 |
| CONF-850989- | (Technical committee on the assessment of incidents in nuclear power plants, Vienna, Austria, 17-20 Sep 1985) | | | |
| 1 | *See* CEA-CONF-8379 | DE87750282 | MN -80 | 12:6652 |
| CONF-8509154- | (International battery testing workshop, Heidelberg, F.R. Germany, 29 Sep-2 Oct 1985) | | | |
| | J. Power Sources, 17: No. 1-3, 64-71(Jan-Apr 1986) | | | 12:6753 |
| | J. Power Sources, 17: No. 1-3, 97-106(Jan-Apr 1986) | | | 12:6754 |
| | J. Power Sources, 17: No. 1-3, 127-134(Jan-Apr 1986) | | | 12:6755 |
| | J. Power Sources, 17: No. 1-3, 248-256(Jan-Apr 1986) | | | 12:6756 |
| CONF-8509303- | (Jolio-Curie school on nuclear matter in all its states, Bombannes, France, 16-20 Sep 1985) | | | |
| 3 | *See* CEA-CONF-8282 | DE87750249 | MN -34C | 12:7720 |
| CONF-8509340- | (Waste heat: recovery and utilization symposium, Portsmouth, UK, 25 Sep 1985) | | | |
| | *See* GB-45 | | ND -95e | 12:6806 |
| CONF-8509341- | (Conference on the value of information as an integral part of aerospace and defence R and D programmes, Cheltenham, UK, 4-5 Sep 1985) | | | |
| | *See* AGARD-CP-85 | | | 12:7862 |
| CONF-8509342- | (Conference on the atmospheres of Saturn and Titan, Alpabach, Austria, 16-19 Sep 1985) | | | |
| | *See* ESA-SP-41 | | | 12:7524 |
| CONF-851054- | (Society of Mining Engineers fall meeting, Albuquerque, NM, USA, 16-18 Oct 1985) | | | |
| | Society of Mining Engineers of AIME, Caller No. D, Littleton, CO 80127 | | | 12:6506 |
| | Society of Mining Engineers of AIME, Caller No. D, Littleton, CO 80127 | | | 12:6568 |
| CONF-8510374- | (Workshop on applications of tethers in space, Venice, Italy, 15-17 Oct 1985) | | | |
| Vol.1 | *See* N-86-28407 | | | 12:6962 |
| CONF-8511150- | (Workshop on triggering, data acquisition and computing for high energy/high luminosity hadron-hadron colliders, Batavia, IL, USA, 11-14 Nov 1985) | | | |
| 12 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002215 | MN -34D | 12:7205 |
| CONF-860106- | (ASHRAE semi-annual meeting, San Francisco, CA, USA, 19-22 Jan 1986) | | | |
| | ASHRAE Trans., 92: No. 1B, 683-694(1986) | | | 12:6490 |
| | ASHRAE Trans., 92: No. 1A, 486-493(1986) | | | 12:6594 |
| | ASHRAE Trans., 92: No. 1B, 119-130(1986) | | | 12:6625 |
| | ASHRAE Trans., 92: No. 1B, 103-118(1986) | | | 12:6626 |
| | ASHRAE Trans., 92: No. 1A, 173-185(1986) | | | 12:6795 |
| | ASHRAE Trans., 92: No. 1A, 453-473(1986) | | | 12:6796 |
| | ASHRAE Trans., 92: No. 1B, 589-602(1986) | | | 12:6797 |
| | ASHRAE Trans., 92: No. 1B, 843-856(1986) | | | 12:6798 |
| | ASHRAE Trans., 92: No. 1A, 246-262(1986) | | | 12:7030 |
| CONF-860126- | (International workshop on polarized sources and targets, Montana, Switzerland, 13-17 Jan 1986) | | | |
| 12 | *See* CEA-CONF-8338 | DE87750264 | MN -34C | 12:7706 |
| CONF-860130- | (24. AIAA aerospace science meeting, Reno, NV, USA, 6-9 Jan 1986) | | | |
| 8 | *See* N-86-28125 | | | 12:6596 |
| CONF-860168- | (Workshop on observable standard model physics at the SSC, Los Angeles, CA, USA, 15-24 Jan 1986) | | | |
| 6 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87000596 | MN -34D | 12:7203 |
| CONF-860169- | (Annual meeting of the Cooling Tower Institute, Houston, TX, USA, 27-29 Jan 1986) | | | |
| | Cooling Tower Institute, 9030 IH-45 North Room 216, Gulfbank Road Exit, Houston, TX 77037 | | | 12:6807 |
| CONF-860189- | (1. national colloquium on paraseismic engineering, Saint-Remy-les-Chevreuse, France, 29-31 Jan 1986) | | | |
| 1 | *See* FRADOC-5-6 | DE87750232 | MN -80 | 12:6714 |
| CONF-8602107- | (BWEA/DEN workshop on aerodynamics and control of wind turbines, Harwell, Oxon, UK, 25 Feb 1986) | | | |
| | *See* ETSU-N-1-86 | | ND -60 | 12:6620 |
| CONF-860340- | (115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting, New Orleans, LA, USA, 2-6 Mar 1986) | | | |
| 10 | *See* N-86-28165 | | | 12:6829 |

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|---|---|---|---|---|
| CONF-860418- | (88. annual meeting of the American Ceramic Society, Chicago, IL, USA, 27 Apr-1 May 1986) | | | |
| 20 | *See* CEA-CONF-8449 | DE87750245 | MN -25 | 12:6885 |
| CONF-860421- | (2. international conference on fusion reactor materials (ICFRM-2), Chicago, IL, USA, 13-17 Apr 1986) | | | |
| 63 | *See* CEA-CONF-8435 | DE87750274 | MN -80 | 12:7802 |
| 64 | *See* CEA-CONF-8413 | DE87750286 | MN -20d | 12:7800 |
| CONF-8604184- | (Symposium on 10 years of uranium beam, Darmstadt, F.R. Germany, 2-4 Apr 1986) | | | |
| 4 | *See* CEA-CONF-8384 | DE87750250 | MN -34C | 12:7721 |
| CONF-8604230- | (International conference on CREEP, Tokyo, Japan, 14-18 Apr 1986) | | | |
| 1 | *See* CEA-CONF-8436 | DE87750267 | MN -79 | 12:6674 |
| CONF-8604260- | (14. international deep drawing research group biennal (IDDRG-14), Koeln, F.R. Germany, 21-23 Apr 1986) | | | |
| 1 | *See* CEA-CONF-8418 | DE87750239 | MN -25 | 12:6819 |
| CONF-8604262- | (16. meeting on actinides, Eibsee, F.R. Germany, 28-30 Apr 1986) | | | |
| 3-Summ. | *See* CEA-CONF-8456 | DE87750243 | MN -4 | 12:6924 |
| CONF-8604263- | (ANATECH '86, Noordwijkerhout, Netherlands, 22-24 Apr 1986) | | | |
| 1 | *See* CEA-CONF-8420 | DE87750244 | MN -86 | 12:6503 |
| CONF-8604264- | (Workshop on industrial applications of optical fiber sensors, Gif-sur-Yvette, France, 16 Apr 1986) | | | |
| 1 | *See* CEA-CONF-8437 | DE87750251 | MN -37 | 12:7218 |
| CONF-8604265- | (5. EuReData conference on reliability data collection and use in risk availability assessment, Heidelberg, F.R. Germany, 9-11 Apr 1986) | | | |
| 1 | *See* CEA-CONF-8434 | DE87750266 | MN -78 | 12:6653 |
| CONF-8604266- | (Tritium meeting, Dijon, France, 23-25 Apr 1986) | | | |
| 1 | *See* CEA-CONF-8416 | DE87750287 | MN -20e | 12:7801 |
| CONF-860506- | (International conference on heavy ion nuclear collisions in the Fermi energy domain, Caen, France, 12-16 May 1986) | | | |
| 3 | *See* CEA-CONF-8441 | DE87750246 | MN -34C | 12:7722 |
| 4-Summ. | *See* CEA-CONF-8450 | DE87750247 | MN -34C | 12:7712 |
| 5 | *See* CEA-CONF-8442 | DE87750248 | MN -34C | 12:7714 |
| 6 | *See* GANIL-P-86-07 | DE87750253 | MN -34C | 12:7710 |
| CONF-860575- | (2. conference on particle and nuclear physics, Lake Louise, Canada, 26-31 May 1986) | | | |
| 57 | *See* ANL-HEP-CP-86-82 | E 1.99: DE87001571 | MN -34C | 12:7679 |
| 58 | *See* DOE/ER/03244-124 | E 1.99: DE87000837 | MN -34C | 12:7707 |
| 59 | *See* DOE/ER/03244-126 | E 1.99: DE87002035 | MN -34C | 12:7658 |
| CONF-8605163- | (Workshop on physics simulation at high energies, Madison, WI, USA, 5-16 May 1986) | | | |
| 6 | *See* ANL-HEP-CP-86-84 | E 1.99: DE87001573 | MN -34D | 12:7693 |
| CONF-8605196- | (EEC hot laboratories meeting, Brasimone, Italy, 21-23 May 1986) | | | |
| 1 | *See* RISO-M-2599 | DE87750157 | MN -4 | 12:6913 |
| CONF-860603- | (4. European nuclear conference and 9. FORATOM congress (ENC '86) and international nuclear trade fair, Geneva, Switzerland, 1-6 Jun 1986) | | | |
| 9 | *See* CEA-CONF-8391 | DE87750259 | MN -20d | 12:7799 |
| 10 | *See* CEA-CONF-8386 | DE87750268 | MN -79 | 12:6672 |
| CONF-860608- | (World congress on high tech ceramics: electronic, engineering, nuclear, biomedical research and applications in focus, Milan, Italy, 23-27 Jun 1986) | | | |
| 8 | *See* CEA-CONF-8426 | DE87750050 | MN -79 | 12:6673 |
| CONF-860610- | (American Nuclear Society annual meeting, Reno, NV, USA, 15-20 Jun 1986) | | | |
| 13 | *See* BNL-NUREG-38266 | TI86013916 | MN -78 | 12:6703 |
| CONF-860652- | (7. topical meeting on the technology of fusion energy, Reno, NV, USA, 15-19 Jun 1986) | | | |
| 30 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001553 | MN -20d | 12:7803 |
| CONF-860654- | (27. annual meeting of the Institute of Nuclear Materials Management, New Orleans, LA, USA, 22-25 Jun 1986) | | | |
| | Nucl. Mater. Manage., 15: 162-169(1986) | | | 12:6502 |
| | Nucl. Mater. Manage., 15: 18-19(1986) | | | 12:6575 |
| | Nucl. Mater. Manage., 15: 483-487(1986) | | | 12:6579 |
| | Nucl. Mater. Manage., 15: 203-207(1986) | | | 12:6580 |
| 1 | *See* BNL-38316 | E 1.99: DE86013910 | MN -15 | 12:6576 |
| CONF-8606101- | (5. international conference on ion beam modification of materials, Catania, Italy, 9-11 Jun 1986) | | | |
| 9 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001556 | MN -25 | 12:6821 |
| CONF-8606151- | (76. annual meeting of the Federation of American Society for Experimental Biology, Washington, DC, USA, 8-12 Jun 1986) | | | |
| | Fed. Proc., Fed. Am. Soc. Exp. Biol., 45: No. 6, 1673(May 1986) | | | 12:7418 |
| | Fed. Proc., Fed. Am. Soc. Exp. Biol., 45: No. 6, 1693(May 1986) | | | 12:7427 |

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|---|---|---|---|---|
| CONF-8606200- | (SFM international spring meeting on high-temperature fatigue, Paris, France, 9-11 Jun 1986) | | | |
| 2 | *See* N-86-28164 | | | 12:6828 |
| CONF-8606215- | (Summer study on the physics of the superconducting super collider, Snowmass, CO, USA, 23 Jun-11 Jul 1986) | | | |
| 8 | *See* ANL-HEP-CP-86-98 | E 1.99: DE87001563 | MN -32 | 12:7656 |
| 14 | *See* BNL-38737 | E 1.99: DE87002143 | MN -28 | 12:7060 |
| CONF-860701- | (23. international conference on high-energy physics, Berkeley, CA, USA, 16-23 Jul 1986) | | | |
| 6 | *See* BNL-38480 | E 1.99: DE86015146 | MN -34D | 12:7201 |
| 31 | *See* LBL-22224 | E 1.99: DE87001721 | MN -34D | 12:7527 |
| 35 | *See* ANL-HEP-CP-86-103 | E 1.99: DE87001551 | MN -34D | 12:7719 |
| 36 | *See* ANL-HEP-CP-86-60 | E 1.99: DE87001549 | MN -34D | 12:7654 |
| 38 | *See* ANL-HEP-CP-86-75 | E 1.99: DE87001546 | MN -34D | 12:7655 |
| 39 | *See* BNL-38767 | E 1.99: DE87002151 | MN -34D | 12:7657 |
| 40 | *See* BNL-38769 | E 1.99: DE87002150 | MN -34D | 12:7694 |
| 43 | *See* DOE/ER/40272-17 | E 1.99: DE87001874 | MN -34D | 12:7696 |
| 44 | *See* ANL-HEP-CP-86-56 | E 1.99: DE87001500 | MN -34D | 12:7653 |
| 45 | *See* ANL-HEP-CP-86-64 | E 1.99: DE87001505 | MN -34D | 12:7200 |
| CONF-860705- | (IEEE Power Engineering Society summer meeting, Mexico City, Mexico, 20-25 Jul 1986) | | | |
| | IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854 | | | 12:6776 |
| CONF-860714- | (22. University conference on ceramics - ceramic microstructures '86: role of interfaces, Berkeley, CA, USA, 28-31 Jul 1986) | | | |
| 5 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001540 | MN -25 | 12:6865 |
| CONF-860746- | (Anomalous rare earths and actinides, Grenoble, France, 7-11 Jul 1986) | | | |
| 11 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001538 | MN -25 | 12:6820 |
| CONF-860786- | (Health and safety conference, Albuquerque, NM, USA, 15-17 Jul 1986) | | | |
| 1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001507 | MN -71 | 12:6505 |
| CONF-860787- | (Advances in medical imaging and related dosimetry conference, Erice, Sicily, Italy, 5-15 Jul 1986) | | | |
| 1 | *See* BNL-38571 | E 1.99: DE87001370 | MN -48 | 12:7422 |
| CONF-860789- | (International workshop on condensed matter theories, Argonne, IL, USA, 21-26 Jul 1986) | | | |
| 1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001537 | MN -34D | 12:7163 |
| CONF-860802- | (International nuclear physics conference, Harrogate, UK, 25-30 Aug 1986) | | | |
| 7 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001529 | MN -34C | 12:7702 |
| CONF-860810- | (Intersociety energy conversion engineering conference, San Diego, CA, USA, 25-29 Aug 1986) | | | |
| 35 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001517 | MN -95e | 12:6586 |
| 38 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001475 | MN -94cb | 12:6751 |
| CONF-860829- | (Annual joint meeting of the Electron Microscopy Society of America and the Microbeam Analysis Society, Albuquerque, NM, USA, 10-15 Aug 1986) | | | |
| 38 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001466 | MN -25 | 12:6906 |
| 39 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001516 | MN -25 | 12:6907 |
| CONF-860877- | (International conference on parallel processing, St. Charles, IL, USA, 19-22 Aug 1986) | | | |
| 2 | *See* DOE/ER/25001-12 | E 1.99: DE87002102 | MN -32 | 12:7844 |
| CONF-860880- | (30. SPIE technical symposium on optics and optoelectronic engineering, San Diego, CA, USA, 17-22 Aug 1986) | | | |
| 32 | *See* DOE/ET/51013-192 | E 1.99: DE87000628 | MN -20f | 12:7747 |
| CONF-860895- | (14. international conference on defects in semiconductors, Paris, France, 18-22 Aug 1986) | | | |
| 6 | *See* LBL-22220 | E 1.99: DE87001718 | MN -25 | 12:6889 |
| CONF-8608105- | (4. circum-Pacific energy and mineral resource conference, Singapore, China, 17-22 Aug 1986) | | | |
| | Am. Assoc. Pet. Geol., Bull., 70: No. 7, 916(Jul 1986) | | | 12:6472 |
| CONF-8608108- | (International seminar on dynamic processes of highly charged ions, Susono, Shizuoka-ken, Japan, 21-24 Aug 1986) | | | |
| 4 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002193 | MN -34A | 12:7634 |
| CONF-8608110- | (Seminar on integrated power plant computer communications, San Francisco, CA, USA, 25-27 Aug 1986) | | | |
| 2 | *See* UCRL-95277 | E 1.99: DE87002386 | MN -32 | 12:7854 |
| CONF-8608123- | (Advanced accelerator concepts conference, Madison, WI, USA, 21-27 Aug 1986) | | | |
| 3 | *See* LA-UR-86-3640 | E 1.99: DE87001979 | MN -28 | 12:7069 |
| 4 | *See* LBL-22301 | E 1.99: DE87001878 | MN -28 | 12:7070 |
| CONF-8608131- | (Ignition Technical Oversight Committee conference, Los Alamos, NM, USA, 12 Aug 1986) | | | |
| Vugraphs | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87000750 | MN -20 | 12:7804 |
| CONF-860906- | (Advances in reactor physics and safety meeting, Saratoga Springs, NY, USA, 17-19 Sep 1986) | | | |
| 6 | *See* UCRL-94839 | E 1.99: DE86013905 | MN -34C | 12:7717 |

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|---|---|---|---|---|
| CONF-860908- | (Operability of nuclear power systems in normal and adverse environments meeting, Albuquerque, NM, USA, 29 Sep-3 Oct 1986) | | | |
| 30 | *See* SAND-86-0634C | E 1.99: DE87001414 | MN -80 | 12:6667 |
| 31 | *See* SAND-86-0703C | TI87000983 | MN -78 | 12:6737 |
| 32 | *See* SAND-86-2266C | TI87000974 | MN -78 | 12:6738 |
| CONF-860914- | (Applied superconductivity conference (ASC '86), Baltimore, MD, USA, 28 Sep-4 Oct 1986) | | | |
| 9 | *See* BNL-38756 | E 1.99: DE87001460 | MN -25 | 12:6818 |
| CONF-860918- | (7. international conference on hyperfine interactions, Bangalore, India, 8-12 Sep 1986) | | | |
| 1 | *See* UCRL-94615 | E 1.99: DE87002161 | MN -34 | 12:7640 |
| CONF-860950- | (17. international congress on high speed photography and photonics, Pretoria, South Africa, 1-5 Sep 1986) | | | |
| 2 | *See* CEA-CONF-8311 | DE87750263 | MN -37 | 12:7202 |
| CONF-860961- | (Instrumentation, components and materials contractors' meeting, Morgantown, WV, USA, 16-17 Sep 1986) | | | |
| 4 | *See* LA-UR-86-3465 | E 1.99: DE87001960 | MN -90e | 12:6910 |
| CONF-860990- | (8. annual participants' information meeting of the DOE Low-Level Waste Management Program, Denver, CO, USA, 22-26 Sep 1986) | | | |
| 7 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001824 | MN -70B | 12:6507 |
| 8 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002186 | MN -70B | 12:6508 |
| CONF-8609127- | (SPIE's fiber LASE '86, Cambridge, MA, USA, 14-26 Sep 1986) | | | |
| 13 | *See* EGG-10282-1120 | E 1.99: DE87002301 | MN -37 | 12:7220 |
| 14 | *See* EGG-10282-1121 | E 1.99: DE87002300 | MN -37 | 12:7221 |
| CONF-8609131- | (8. international free electron laser conference, Glasgow, UK, 1-5 Sep 1986) | | | |
| 7 | *See* LA-UR-86-3444 | E 1.99: DE87001958 | MN -37 | 12:6990 |
| CONF-8609134- | (Geochemical modelling workshop, Fallen Leaf Lake, CA, USA, 14-17 Sep 1986) | | | |
| 1 | *See* LA-UR-86-3543 | E 1.99: DE87001765 | MN -11 | 12:7504 |
| CONF-8609150- | (International symposium on gallium arsenide and related compounds, Las Vegas, NV, USA, 28 Sep-1 Oct 1986) | | | |
| 5 | *See* LBL-22260 | E 1.99: DE87001892 | MN -25 | 12:6890 |
| CONF-8609163- | (International conference and symposia on unified concepts of many-body problems, Stony Brook, NY, USA, 4-6 Sep 1986) | | | |
| 3 | *See* LA-UR-86-3582 | E 1.99: DE87001969 | MN -34C | 12:7683 |
| CONF-8609173- | (2. conference on hypercube multiprocessors, Knoxville, TN, USA, 29-30 Sep 1986) | | | |
| 2 | *See* SAND-86-1693C | E 1.99: DE87000449 | MN -32 | 12:7853 |
| CONF-8609192- | (19. annual electronics and aerospace conference, Washington, DC, USA, 9 Sep 1986) | | | |
| 1 | *See* N-86-28122 | | | 12:6624 |
| CONF-861007- | (Nuclear science and nuclear power systems symposium, Washington, DC, USA, 29-31 Oct 1986) | | | |
| 3 | *See* EGG-10282-2100 | E 1.99: DE87002204 | MN -37 | 12:7208 |
| 4 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002174 | MN -37 | 12:7204 |
| CONF-861008- | (Fuel cell seminar, Tucson, AZ, USA, 26-30 Oct 1986) | | | |
| 1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001457 | MN -95f | 12:6802 |
| CONF-861013- | (4. international conference on water chemistry of nuclear reactor systems, Bournemouth, UK, 13-17 Oct 1986) | | | |
| 1 | *See* CEA-CONF-8472 | DE87750230 | MN -78 | 12:6654 |
| CONF-861019- | (10. international vacuum congress and 6. international conference on solid surfaces and the 33. national symposium of the American Vacuum Society, Baltimore, MD, USA, 27-31 Oct 1986) | | | |
| 7 | *See* BNL-38696 | E 1.99: DE87001371 | MN -4 | 12:6923 |
| 10 | *See* BNL-38702 | E 1.99: DE87001468 | MN -25 | 12:6817 |
| CONF-861044- | (Hanford Life Sciences symposium: radiation protection-a look to the future - celebrating four decades of research at Hanford, Richland, WA, USA, 21-23 Oct 1986) | | | |
| 2 | *See* PNL-SA-14090 | E 1.99: DE87002063 | MN -41 | 12:7481 |
| CONF-861068- | (Electrochemical Society fall meeting, San Diego, CA, USA, 19-24 Oct 1986) | | | |
| 11 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001795 | MN -95f | 12:6887 |
| 12 | *See* SAND-86-1082C | E 1.99: DE87002050 | MN -94cb | 12:6752 |
| CONF-861080- | (Society of Petroleum Engineers annual technical conference and exhibition, New Orleans, LA, USA, 5-8 Oct 1986) | | | |
| | Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836 | | | 12:6480 |
| | Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836 | | | 12:6481 |
| | Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836 | | | 12:6492 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| CONF-8610115- | (4. international symposium on the production and neutralization of negative ions and beams, Upton, NY, USA, 27-31 Oct 1986) | | | |
| 1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002173 | MN -34 | 12:7635 |
| CONF-8610135- | (14. water reactor safety information meeting, Gaithersburg, MD, USA, 27-31 Oct 1986) | | | |
| 3 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002184 | MN -78 | 12:6711 |
| CONF-8610149- | (Advisory group meeting on comparison of nuclear analytical methods with competitive methods, Oak Ridge, TN, USA, 3-7 Oct 1986) | | | |
| 3 | *See* SAND-86-2315C | E 1.99: DE87001734 | MN -28 | 12:6914 |
| CONF-8610155- | (18. annual frontiers of power conference, Stillwater, OK, USA, 28-29 Oct 1986) | | | |
| 1 | *See* IS-M-564 | DE86011433 | MN -90i | 12:6455 |
| CONF-8610159- | (International symposium on the physics and chemistry of small clusters, Richmond, VA, USA, 28 Oct-1 Nov 1986) | | | |
| 1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002170 | MN -34 | 12:7736 |
| CONF-861102- | (American Nuclear Society and Atomic Industrial Forum joint meeting, Washington, DC, USA, 16-21 Nov 1986) | | | |
| 25 | *See* LA-UR-86-3562 | E 1.99: DE87001966 | MN -38 | 12:6966 |
| CONF-861104- | (International symposium on nuclear material safeguards, Vienna, Austria, 10-14 Nov 1986) | | | |
| 8 | *See* BNL-38665 | E 1.99: DE87002156 | MN -15 | 12:7716 |
| CONF-861106- | (IAEA international conference on plasma physics and controlled nuclear fusion research, Kyoto, Japan, 12-19 Nov 1986) | | | |
| 6 | *See* IAEA-CN-47/D-I-4 | E 1.99: DE87000884 | MN -20f | 12:7751 |
| 9 | *See* IAEA-CN-47/D-III-1 | E 1.99: DE87001832 | MN -20 | 12:7752 |
| 11 | *See* UCRL-95567 | E 1.99: DE87002162 | MN -20a | 12:7757 |
| 12 | *See* LA-UR-86-3524 | E 1.99: DE87001764 | MN -20d | 12:7807 |
| CONF-861111- | (Conference on magnetism and magnetic materials, Baltimore, MD, USA, 17-21 Nov 1986) | | | |
| 10 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001684 | MN -25 | 12:7735 |
| 12 | *See* BNL-38773 | E 1.99: DE87002148 | MN -25 | 12:6884 |
| 13 | *See* BNL-38821 | E 1.99: DE87002141 | MN -34C | 12:7734 |
| CONF-861114- | (9. international conference on application of accelerators in research and industry, Denton, TX, USA, 10-12 Nov 1986) | | | |
| 18 | *See* LA-UR-86-3636 | E 1.99: DE87001978 | MN -34 | 12:7157 |
| 19 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002190 | MN -28 | 12:7219 |
| 20 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002176 | MN -34A | 12:7632 |
| 21 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87002177 | MN -28 | 12:7079 |
| CONF-861146- | (AIChE winter annual meeting, Miami, FL, USA, 2-7 Nov 1986) | | | |
| 6 | *See* IS-M-588 | E 1.99: DE87001860 | MN -4 | 12:6456 |
| 7 | *See* SAND-86-1608C | E 1.99: DE87001738 | MN -91 | 12:6499 |
| CONF-861211- | (American Society of Mechanical Engineers winter meeting, Anaheim, CA, USA, 7-12 Dec 1986) | | | |
| 16 | *See* N-86-28378 | | | 12:6959 |
| CONF-861231- | (Communication on the material science and engineering study conference, Boston, MA, USA, 1-5 Dec 1986) | | | |
| 2 | *See* LA-UR-86-3394 | E 1.99: DE87001953 | MN -28 | 12:7156 |
| CPRL- | | | | |
| 2-86 | *See* AD-A-172022/6/XAB | | | 12:6989 |
| CRSR- | | | | |
| 849 | *See* N-86-31466 | | | 12:7563 |
| CSRD- | | | | |
| 546 | *See* DOE/ER/25001-12 | E 1.99: DE87002102 | MN -32 | 12:7844 |
| CUED-F-CAMS-TR- | | | | |
| 240-REV | *See* PB-86-245685/XAB | | | 12:7851 |
| CWI-CS- | | | | |
| R8515 | NTIS, PC A02/MF A01 | | | 12:7843 |
| DHHS/PUB/NIOSH- | | | | |
| 86/ 109 | *See* PB-86-242625/XAB | | | 12:6759 |
| DOE/AL/10752- | | | | |
| 35 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: DE87002504 | MN -70 | 12:6509 |
| DOE/AL/18071- | | | | |
| T6 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: DE87001859 | MN -25 | 12:6822 |
| T10 | NTIS, PC A16/MF A01; 1 (GPO Dep.) | E 1.99: DE87001858 | MN -25 | 12:6823 |
| DOE/BP/11191- | | | | |
| 2 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: DE87002220 | MN -60 | 12:6618 |
| DOE/BP/15104- | | | | |
| 1 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: DE87002228 | MN -98E | 12:6803 |
| DOE/CE/15200- | | | | |
| T2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE86011480 | MN -38 | 12:6824 |
| DOE/DP/10529- | | | | |
| 1 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: DE87002158 | MN -21 | 12:7805 |
| DOE/EIA- | | | | |
| 0226(86/ 08) | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: DE87002527 | MN -98E | 12:6773 |
| 0397(86/ 2Q) | NTIS, PC A15/MF A01 - GPO; 1 (GPO Dep.) | E 1.99: DE87002260 | MN -98E | 12:6774 |

| Report Number | Availability Source | File Number | | Distribution Category | Abstract Number |
|---|---|---|---|---|---|
| DOE/ER-0045/ 16 | D; 2 | | DE87002337 | STD 20C | 12:7806 |
| DOE/ER/03244-124 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87000837 | MN -34C | 12:7707 |
| DOE/ER/03244-126 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002035 | MN -34C | 12:7658 |
| DOE/ER/04215-T3 | NTIS, PC A07; 3 | | DE87002269 | MN -34C | 12:7715 |
| DOE/ER/05096-23 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002444 | MN -34D | 12:7651 |
| DOE/ER/10371-8 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002430 | MN -34A | 12:7636 |
| DOE/ER/10508-T3 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87001871 | MN -25 | 12:6825 |
| DOE/ER/10578-6 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002447 | MN -34C | 12:7206 |
| DOE/ER/10634-1 | NTIS, PC A04; 3 | | DE87002212 | MN -35 | 12:6925 |
| DOE/ER/10637-T1 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87002309 | MN -48 | 12:7415 |
| DOE/ER/10713-7A | NTIS, PC A02; 3 | | DE87002431 | MN -34D | 12:7695 |
| 7B | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002432 | MN -34D | 12:7207 |
| DOE/ER/10714-6 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002426 | MN -34C | 12:7703 |
| DOE/ER/10763-5 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002211 | MN -11 | 12:7501 |
| DOE/ER/13125-T1 | NTIS, PC A10/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002208 | MN -48 | 12:7426 |
| DOE/ER/13256-T1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002037 | MN -4 | 12:6908 |
| DOE/ER/13277-T1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002038 | MN -4 | 12:6926 |
| DOE/ER/13299-3 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001903 | MN -4 | 12:6927 |
| DOE/ER/13391-1 | NTIS, PC A02; 3 | | DE87000782 | MN -11 | 12:7498 |
| DOE/ER/13510-T2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002459 | MN -48 | 12:7508 |
| DOE/ER/25001-12 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002102 | MN -32 | 12:7844 |
| 18 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002098 | MN -32 | 12:7845 |
| DOE/ER/40136-T4 | American Institute of Physics, 335 E. 45th St., New York, NY 10017 | | TI87000192 | ND -28 | 12:7061 |
| DOE/ER/40143-3 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002439 | MN -34D | 12:7659 |
| DOE/ER/40219-2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002438 | MN -34D | 12:7681 |
| DOE/ER/40237-T2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001655 | MN -4 | 12:6954 |
| DOE/ER/40269-1 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE87000830 | MN -34C | 12:7704 |
| DOE/ER/40272-17 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87001874 | MN -34D | 12:7696 |
| DOE/ER/40285-T1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002428 | MN -34C | 12:7708 |
| DOE/ER/45131-3 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002315 | MN -34 | 12:7648 |
| DOE/ER/45162-2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002521 | MN -34 | 12:6826 |
| DOE/ER/45246-1 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002436 | MN -34A | 12:7737 |
| DOE/ER/53216-1 | NTIS, PC A10/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002120 | MN -20 | 12:7746 |
| DOE/ER/60015-2 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002523 | MN -48 | 12:7484 |
| DOE/ER/60147-T2 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002534 | MN -48 | 12:7462 |
| DOE/ER/60327-T1 | NTIS, PC A04/MF A01; 3 | | DE87001670 | MN -11 | 12:7516 |
| DOE/ET/51013-192 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87000628 | MN -20f | 12:7747 |
| DOE/ET/53088-235 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87001933 | MN -20g | 12:7748 |
| DOE/EV/00641-54 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002342 | MN -11 | 12:7373 |
| T1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002343 | MN -48 | 12:7374 |
| DOE/EV/04330-1 | NTIS, PC A02; 3 | | DE87002276 | MN -48 | 12:7416 |
| DOE/EV/10259-T3 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002529 | MN -48 | 12:7384 |
| DOE/FE-0075 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002349 | MN -90 | 12:6393 |

| Report Number | Availability Source | File Number | | Distribution Category | Abstract Number |
|---|---|---|---|---|---|
| DOE/FE/05081-2196 | NTIS, PC A09; 3 | | DE87001450 | MN -90c | 12:6394 |
| DOE/FE/60181-2124 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001012 | STD -90 | 12:6395 |
| 2128 | NTIS MF A01; 2 (GPO Dep.) | E 1.99: | DE87001016 | STD -90 | 12:6468 |
| 2129 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001017 | STD -90 | 12:6396 |
| 2165 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001018 | STD -90 | 12:6397 |
| DOE/FE/60600-T5 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001394 | MN -92 | 12:6483 |
| DOE/ID/01745-T11 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002302 | MN -90g | 12:6777 |
| DOE/ID/12254-1-Vol.3 | NTIS, PC A17/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002448 | MN -97e | 12:6589 |
| DOE/ID/12428-1 | NTIS, PC A13/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002073 | MN -95f | 12:6804 |
| DOE/ID/12521-1 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002509 | STD -95f | 12:6805 |
| DOE/MC/20037-2231 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE87000652 | MN -92 | 12:7517 |
| DOE/MC/21096-2192 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001006 | STD -90c | 12:6398 |
| DOE/MC/21168-2023 | NTIS, PC A09/MF A01; 1 (GPO Dep.) | E 1.99: | DE86006625 | STD -90c | 12:6399 |
| DOE/METC-86/ 0242 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE86006624 | STD -90c | 12:6400 |
| 87/ 4067 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87001003 | MN -90b | 12:6470 |
| DOE/NASA-0247-2 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001863 | STD -60 | 12:6619 |
| DOE/NBM-7001822 | NTIS, PC A06/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001822 | MN -13 | 12:6577 |
| DOE/OR/20722-99-Rev.1 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002727 | MN -70A | 12:6510 |
| DOE/PC/50003-23 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87001919 | MN -90d | 12:6429 |
| 24 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87001643 | MN -90d | 12:6430 |
| 33 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: | DE87002275 | MN -90d | 12:6431 |
| DOE/PC/50801-T2 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE86012197 | MN -90a | 12:6443 |
| DOE/PC/62684-T2-Pt.1 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE86015391 | STD -90b | 12:6463 |
| DOE/PC/70003-T11 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: | DE87002202 | MN -90d | 12:6464 |
| DOE/PC/70006-T6 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001895 | MN -90d | 12:6444 |
| DOE/PC/70774-T4 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: | DE86016120 | STD -90d | 12:6432 |
| DOE/PC/70797-T3 | D; 2 (GPO Dep.) | E 1.99: | DE87001947 | MN -90d | 12:6433 |
| T6 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001950 | MN -90d | 12:6434 |
| T7 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001951 | MN -90d | 12:6435 |
| DOE/PC/70802-T4 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002016 | MN -90d | 12:6436 |
| DOE/PC/80530-T3 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001909 | MN -90a | 12:6465 |
| DOE/PC/80532-5 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87001906 | MN -90b | 12:6445 |
| DOE/PC/80533-T4 | NTIS, PC A04/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002017 | MN -90a | 12:6446 |
| DOE/PETC/TR-87/ 1 | NTIS, PC A10/MF A01 (GPO Dep.) | E 1.99: | DE87002510 | STD -90i | 12:6454 |
| 87/ 4 | NTIS, PC A04/MF A01 (GPO Dep.) | E 1.99: | DE87002513 | STD -90d | 12:6447 |
| DOE/SF/12230-T1 | NTIS, PC A08/MF A01; 1 (GPO Dep.) | E 1.99: | DE87000339 | MN -66a | 12:6607 |
| DPH-N-S-2308 | *See* CEA-CONF-8282 | | DE87750249 | MN -34C | 12:7720 |
| DPST-84-507 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: | DE87002662 | MN -70 | 12:6511 |
| DSP-DO-27-75 | *See* PB-86-246261/XAB | | | | 12:7376 |
| E-2652 | *See* N-86-30160 | | | | 12:6968 |
| 2704 | *See* N-86-28464 | | | | 12:6831 |
| 2951 | *See* N-86-28125 | | | | 12:6596 |
| 3000 | *See* N-86-28165 | | | | 12:6829 |
| 3001 | *See* N-86-28776 | | | | 12:7738 |
| 3075 | *See* N-86-28164 | | | | 12:6828 |
| 3081 | *See* N-86-28445 | | | | 12:6893 |
| 3137 | *See* N-86-28378 | | | | 12:6959 |
| 3140 | *See* N-86-28122 | | | | 12:6624 |
| 3141 | *See* N-86-28651 | | | | 12:7847 |
| 3167 | *See* N-86-29908 | | | | 12:6894 |
| ECTB-152-18A | *See* PB-86-236155/XAB | | | | 12:7325 |

| Report Number | Availability Source | File Number | Distribution Category | Abstract Number |
|---|---|---|---|---|
| **EEG-** | | | | |
| 35 | *See* DOE/AL/10752-35 | E 1.99: DE87002504 | MN -70 | 12:6509 |
| **EGG-** | | | | |
| 10282-1120 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002301 | MN -37 | 12:7220 |
| 10282-1121 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002300 | MN -37 | 12:7221 |
| 10282-2100 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002204 | MN -37 | 12:7208 |
| 10282-2122 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87002375 | MN -13 | 12:7830 |
| **EGG-EA-** | | | | |
| 7521 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: DE87001429 | MN -23 | 12:6694 |
| **EGG-M-** | | | | |
| 13185 | NTIS, PC A02/MF A01 - GPO | TI87001443 | MN -78 | 12:6712 |
| **EGG-TMI-** | | | | |
| 7385 | NTIS, PC A08/MF A01; 1 (GPO Dep.) | E 1.99: DE87002595 | MN -78 | 12:6713 |
| **EI-** | | | | |
| 84-0408 | *See* N-86-29024 | | | 12:6928 |
| **EPA-** | | | | |
| 86-96935 | *See* N-86-27946 | | | 12:7529 |
| 450/ 2-78/ 027R | *See* PB-86-245248/XAB | | | 12:7354 |
| 450/ 4-83/ 003C | *See* PB-86-242757/XAB | | | 12:7343 |
| 520/ 1-85/ 010 | *See* PB-86-244936/XAB | | | 12:6570 |
| 520/ 1-85/ 014 | *See* PB-86-247970/XAB | | | 12:7495 |
| 520/ 1-86/ 013 | *See* PB-86-244845/XAB | | | 12:6459 |
| 600/ 8-86/ 024 | *See* PB-86-242450/XAB | | | 12:7340 |
| 600/ 8-86/ 025 | *See* PB-86-237682/XAB | | | 12:7334 |
| 600/ 8-86/ 027 | *See* PB-86-241031/XAB | | | 12:7337 |
| 600/ D-86/ 180 | *See* PB-86-240967/XAB | | | 12:7486 |
| 600/ D-86/ 184 | *See* PB-86-241015/XAB | | | 12:7487 |
| 600/ D-86/ 187 | *See* PB-86-242468/XAB | | | 12:7341 |
| 600/ D-86/ 188 | *See* PB-86-241098/XAB | | | 12:7338 |
| 600/ D-86/ 189 | *See* PB-86-240934/XAB | | | 12:7485 |
| 904/ 9-86/ 141 | *See* PB-86-244191/XAB | | | 12:6761 |
| **EPRI-AP-** | | | | |
| 4712 | Research Reports Center, Box 50490, Palo Alto, CA 94303 | TI87920048 | ND -97e | 12:6590 |
| 4832 | Research Reports Center, Box 50490, Palo Alto, CA 94303 | TI87920050 | ND -90c | 12:6437 |
| **EPRI-EL-** | | | | |
| 3880-Vol.2 | Research Reports Center, Box 50490, Palo Alto, CA 94303 | TI87920079 | ND -97 | 12:6627 |
| **EPRI-EM-** | | | | |
| 4790-CCM-Vol.1 | Research Reports Center, Box 50490, Palo Alto, CA 94303 | TI87920083 | ND -95f | 12:6769 |
| **EPRI-NP-** | | | | |
| 4831 | Research Reports Center, Box 50490, Palo Alto, CA 94303 | TI87920091 | ND -78 | 12:6655 |
| **ERNO-** | | | | |
| 71-AHF/ 2 | NTIS, PC A08/MF A01 | | | 12:6964 |
| **ESA-** | | | | |
| 86-96852 | *See* ESA-SP-41 | | | 12:7524 |
| 86-97069 | *See* OEFZS-334 | | | 12:7017 |
| **ESA-CR(P)-** | | | | |
| 2156 | *See* ERNO-71-AHF/2 | | | 12:6964 |
| **ESA-SP-** | | | | |
| 41 | NTIS, PC A14/MF A01 | | | 12:7524 |
| 43 | NTIS, PC A16/MF A01 | | | 12:6888 |
| **ESE-** | | | | |
| 80-610-119 | *See* PB-86-243318/XAB | | | 12:7346 |
| 80-610-119F | *See* PB-86-243326/XAB | | | 12:7347 |
| 81-631-600-008F | *See* PB-86-243292/XAB | | | 12:7345 |
| 82-615-0600-2110 | *See* PB-86-243367/XAB | | | 12:7351 |
| 83-152-0602-0120-VOL-1 | *See* PB-86-243334/XAB | | | 12:7348 |
| 83-152-0602-0120-VOL-2 | *See* PB-86-243342/XAB | | | 12:7349 |
| **ETSU-N-** | | | | |
| 1-86 | BLDSC, Boston Spa, Wetherby, West Yorks | | ND -60 | 12:6620 |
| **ETSU-R-** | | | | |
| 39 | HMSO, London price Pound 8.00 | | ND -66a | 12:6606 |
| **ETSU-WV-** | | | | |
| 1570 | British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ | | ND -97e | 12:6612 |
| 1570-P17 | British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ | | ND -97e | 12:6613 |
| 1570-P21 | British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ | | ND -97e | 12:6614 |
| 1570-P24 | British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ | | ND -97e | 12:6615 |
| 1570-P26 | British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ | | ND -97e | 12:6616 |
| **FIPS/PUB-** | | | | |
| 104-1/ XAB | NTIS, PC A02/MF A01 | | | 12:7864 |
| **FRADOC-** | | | | |
| 5-1 | NTIS (US Sales Only), PC A02/MF A01 | DE87750237 | MN -80 | 12:6687 |
| 5-2 | NTIS (US Sales Only), PC A02/MF A01 | DE87750236 | MN -80 | 12:6688 |

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| 5-3 | NTIS (US Sales Only), PC A02/MF A01 | DE87750235 | MN -78 | 12:6656 |
| 5-4 | NTIS (US Sales Only), PC A02/MF A01 | DE87750234 | MN -78 | 12:6657 |
| 5-5 | NTIS (US Sales Only), PC A02/MF A01 | DE87750233 | MN -80 | 12:6689 |
| 5-6 | NTIS (US Sales Only), PC A02/MF A01 | DE87750232 | MN -80 | 12:6714 |
| 5-7 | NTIS (US Sales Only), PC A02/MF A01 | DE87750231 | MN -78 | 12:6658 |
| **FRNC-TH-** | | | | |
| 2283 | NTIS (US Sales Only), PC A12/MF A01 | DE87750035 | MN -48 | 12:7423 |
| 2387 | NTIS (US Sales Only), PC A15/MF A01 | DE87750281 | MN -79 | 12:6675 |
| **GANIL-** | | | | |
| 85-01 | NTIS (US Sales Only), PC A02/MF A01 | DE87750254 | MN -2 | 12:7865 |
| **GANIL-P-** | | | | |
| 85-15 | NTIS (US Sales Only), PC A02/MF A01 | DE87750252 | MN -34C | 12:7723 |
| 86-07 | NTIS (US Sales Only), PC A02/MF A01 | DE87750253 | MN -34C | 12:7710 |
| **GB-** | | | | |
| 45 | BLDSC, Boston Spa, Wetherby, West Yorks | | ND -95e | 12:6806 |
| **GCA-TR-** | | | | |
| 80-114-G | *See* PB-86-237716/XAB | | | 12:7335 |
| **GJ/TMC-** | | | | |
| 01-Ed.2 | NTIS, PC A05/MF A01; 1 | DE87001841 | STD -70A | 12:6574 |
| **GKSS-** | | | | |
| 86/ E/ 17 | NTIS (US Sales Only), PC A08/MF A01 | DE87750083 | MN -80 | 12:6715 |
| **GSI-** | | | | |
| 86-20-Prepr. | NTIS (US Sales Only), PC A02/MF A01 | DE87750080 | MN -34C | 12:7724 |
| 86-21-Prepr. | NTIS (US Sales Only), PC A03/MF A01 | DE87750073 | MN -34A | 12:7637 |
| **HEDL-SA-** | | | | |
| 3296-FP | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87000187 | MN -70 | 12:6827 |
| **HETA-** | | | | |
| 84-043 | *See* PB-86-236148/XAB | | | 12:7324 |
| 84-379 | *See* PB-86-237138/XAB | | | 12:7330 |
| 85-152-1684 | *See* PB-86-236197/XAB | | | 12:7328 |
| **HRP-** | | | | |
| 0906956/ 8/ XAB | NTIS, PC A02/MF A01 | | | 12:7424 |
| **IAEA-CN-** | | | | |
| 47/ C-I-1 | *See* UCRL-95567 | E 1.99: DE87002162 | MN -20a | 12:7757 |
| 47/ D-I-4 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87000884 | MN -20f | 12:7751 |
| 47/ D-III-1 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001832 | MN -20 | 12:7752 |
| **IAEA-SM-** | | | | |
| 293-122 | *See* BNL-38665 | E 1.99: DE87002156 | MN -15 | 12:7716 |
| **ICASE-** | | | | |
| 86-30 | *See* N-86-30425 | | | 12:7849 |
| 86-54 | *See* N-86-30380 | | | 12:7848 |
| **IFSR-** | | | | |
| 235 | *See* DOE/ET/53088-235 | E 1.99: DE87001933 | MN -20g | 12:7748 |
| **IKE-** | | | | |
| 6-168 | NTIS (US Sales Only), PC A07/MF A01 | DE87750075 | MN -34C | 12:7730 |
| **IMFL-** | | | | |
| 3115 | *See* REPT-4/70 | | | 12:7018 |
| **INIS-mf-** | | | | |
| 10308 | NTIS (US Sales Only), PC A08/MF A01 | DE87750072 | MN -11 | 12:7361 |
| **IPNO-DRE-** | | | | |
| 85-24 | NTIS (US Sales Only), PC A03/MF A01 | DE87750278 | MN -4 | 12:6955 |
| **IPNO-TH-** | | | | |
| 86-8 | NTIS (US Sales Only), PC A02/MF A01 | DE87750288 | MN -34C | 12:7725 |
| 86-17 | NTIS (US Sales Only), PC A02/MF A01 | DE87750279 | MN -34D | 12:7692 |
| **IPP-** | | | | |
| 4/ 227 | NTIS (US Sales Only), PC A02/MF A01 | DE87750085 | MN -20a | 12:7753 |
| **IS-M-** | | | | |
| 564 | NTIS, PC A02/MF A01 | DE86011433 | MN -90i | 12:6455 |
| 588 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87001860 | MN -4 | 12:6456 |
| **IUHEE-** | | | | |
| 385 | *See* ANL-HEP-CP-86-56 | E 1.99: DE87001500 | MN -34D | 12:7653 |
| **IWS-** | | | | |
| 64.17 | *See* PB-86-236189/XAB | | | 12:7327 |
| 143.19 | *See* PB-86-237658/XAB | | | 12:7332 |
| 143.20 | *See* PB-86-237278/XAB | | | 12:7331 |
| 147.22 | *See* PB-86-237666/XAB | | | 12:7333 |
| 147.36 | *See* PB-86-246949/XAB | | | 12:7356 |
| 147.36 | *See* PB-86-242724/XAB | | | 12:7428 |
| **JHU/EECS-** | | | | |
| 86/ 07 | *See* AD-A-171686/9/XAB | | | 12:7837 |
| **JPL-PUB-** | | | | |
| 85-101 | *See* N-86-28196 | | | 12:6892 |
| **JPL-PUB-D-** | | | | |
| 2581 | *See* AD-A-171893/1/XAB | | | 12:6482 |
| **Juel-** | | | | |
| 2045 | NTIS (US Sales Only), PC A05/MF A01 | DE87750077 | MN -80 | 12:6716 |
| 2046 | NTIS (US Sales Only), PC A09/MF A01 | DE87750084 | MN -80 | 12:6669 |
| 2051-Trans. | NTIS (US Sales Only), PC A03/MF A01 | DE87750081 | MN -80 | 12:6691 |
| **Juel-Spez-** | | | | |
| 349 | NTIS (US Sales Only), PC A04/MF A01 | DE87750079 | MN -11 | 12:7400 |
| 354 | NTIS (US Sales Only), PC A07/MF A01 | DE87750076 | MN -13 | 12:7866 |
| **K-** | | | | |
| 2051-Rev.1 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: DE87002092 | STD -4 | 12:6909 |

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| K/OA- | | | | |
| 6039 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87002526 | MN -15 | 12:6578 |
| KT- | | | | |
| 85-038(R) | *See* AD-A-171862/6/XAB | | | 12:7246 |
| L- | | | | |
| 16129 | *See* N-86-30485 | | | 12:7727 |
| 16132 | *See* N-86-28385 | | | 12:6581 |
| LA- | | | | |
| 10661-HDR | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87002244 | STD -66b | 12:6609 |
| 10819-T | NTIS, PC A10/MF A01; 1 (GPO Dep.) | E 1.99: DE87002229 | STD -34B | 12:7526 |
| LA/Sub- | | | | |
| D3866F-1 | NTIS, PC A03/MF A01; 1 (GPO Dep.) | E 1.99: DE87002308 | MN -38 | 12:6965 |
| LA-UR- | | | | |
| 86-3394 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001953 | MN -28 | 12:7156 |
| 86-3444 | NTIS, PC A03/MF A01 (GPO Dep.) | E 1.99: DE87001958 | MN -37 | 12:6990 |
| 86-3465 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001960 | MN -90e | 12:6910 |
| 86-3524 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001764 | MN -20d | 12:7807 |
| 86-3543 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001765 | MN -11 | 12:7504 |
| 86-3562 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001966 | MN -38 | 12:6966 |
| 86-3582 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001969 | MN -34C | 12:7683 |
| 86-3636 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001978 | MN -34 | 12:7157 |
| 86-3640 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001979 | MN -28 | 12:7069 |
| LAL- | | | | |
| 85-14 | NTIS (US Sales Only), PC A09/MF A01 | DE87750285 | MN -34D | 12:7660 |
| LAL-RT- | | | | |
| 86-01 | NTIS (US Sales Only), PC A03/MF A01 | DE87750265 | MN -37 | 12:7209 |
| LBL- | | | | |
| 21916 | NTIS, PC A06/MF A01; 1 (GPO Dep.) | E 1.99: DE87002569 | MN -34D | 12:7697 |
| 22100 | NTIS, PC A07/MF A01; 1 (GPO Dep.) | E 1.99: DE87001725 | MN -4 | 12:6949 |
| 22220 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001718 | MN -25 | 12:6889 |
| 22224 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001721 | MN -34D | 12:7527 |
| 22260 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87001892 | MN -25 | 12:6890 |
| 22301 | NTIS, PC A02/MF A01 (GPO Dep.) | E 1.99: DE87001878 | MN -28 | 12:7070 |
| 22304 | NTIS, PC A05/MF A01; 1 (GPO Dep.) | E 1.99: DE87002545 | MN -34D | 12:7698 |
| LMSC-D- | | | | |
| 067295 | *See* AD-A-171624/0/XAB | | | 12:6814 |
| LPI-TR- | | | | |
| 86-01 | *See* N-86-28811 | | | 12:7532 |
| 86-04 | *See* N-86-28535 | | | 12:7509 |
| LUIP- | | | | |
| 8409 | NTIS (US Sales Only), PC A02/MF A01 | DE87750161 | MN -34A | 12:7731 |
| 8413 | NTIS (US Sales Only), PC A02/MF A01 | DE87750162 | MN -34A | 12:7638 |
| 8514 | NTIS (US Sales Only), PC A02/MF A01 | DE87750167 | MN -34C | 12:7709 |
| LUNFD6-NFFK- | | | | |
| 7047-1-9(1984) | *See* LUIP-8409 | DE87750161 | MN -34A | 12:7731 |
| 7052-1-9(1984) | *See* LUIP-8413 | DE87750162 | MN -34A | 12:7638 |
| 7067-1-9(1985) | *See* LUIP-8514 | DE87750167 | MN -34C | 12:7709 |
| LYCEN- | | | | |
| 8547 | NTIS (US Sales Only), PC A02/MF A01 | DE87750258 | MN -34D | 12:7684 |
| MAP-HANDBK- | | | | |
| 8 | NTIS, PC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, IL 61801 | | | 12:7270 |
| MHSMP- | | | | |
| 86-39 | NTIS, PC A02/MF A01; 1 (GPO Dep.) | E 1.99: DE87002086 | STD -4 | 12:6911 |
| MINTEK-M- | | | | |
| 245 | *See* PB-86-244076/XAB | | | 12:6501 |
| MIT/LCS/TM- | | | | |
| 306 | *See* AD-A-171505/1/XAB | | | 12:7834 |
| 307 | *See* AD-A-171546/5/XAB | | | 12:7835 |
| MT-TNO- | | | | |
| 8724-11344 | *See* REPT-5-010880-PT-2 | | | 12:6622 |
| N- | | | | |
| 86-26992 | NTIS, PC A03/MF A01 | | | 12:7846 |
| 86-27946 | NTIS, PC A14/MF A01 | | | 12:7529 |
| 86-28122 | NTIS, PC A02/MF A01 | | | 12:6624 |
| 86-28125 | NTIS, PC A02/MF A01 | | | 12:6596 |
| 86-28139 | NTIS, PC A07/MF A01 | | | 12:6958 |
| 86-28164 | NTIS, PC A02/MF A01 | | | 12:6828 |
| 86-28165 | NTIS, PC A02/MF A01 | | | 12:6829 |
| 86-28195 | NTIS, PC A02/MF A01 | | | 12:6891 |
| 86-28196 | NTIS, PC A04/MF A01 | | | 12:6892 |
| 86-28375 | NTIS, PC A09/MF A01 | | | 12:7011 |
| 86-28378 | NTIS, PC A02/MF A01 | | | 12:6959 |
| 86-28385 | NTIS, PC A02/MF A01 | | | 12:6581 |
| 86-28399 | NTIS, PC A04/MF A01 | | | 12:6991 |
| 86-28407 | NTIS, PC A25/MF A01 | | | 12:6962 |
| 86-28445 | NTIS, PC A03/MF A01 | | | 12:6893 |
| 86-28462 | NTIS, PC A09/MF A01 | | | 12:6830 |
| 86-28464 | NTIS, PC A02/MF A01 | | | 12:6831 |
| 86-28535 | NTIS, PC A09/MF A01 | | | 12:7509 |
| 86-28651 | NTIS, PC A02/MF A01 | | | 12:7847 |
| 86-28709 | NTIS, PC A02/MF A01 | | | 12:7740 |
| 86-28721 | NTIS, PC A02/MF A01 | | | 12:7726 |

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| 86-28728 | NTIS, PC A02/MF A01 | | | 12:7216 |
| 86-28729 | NTIS, PC A08/MF A01 | | | 12:7222 |
| 86-28776 | NTIS, PC A03/MF A01 | | | 12:7738 |
| 86-28811 | NTIS, PC A06/MF A01 | | | 12:7532 |
| 86-28892 | NTIS, PC A02/MF A01 | | | 12:7545 |
| 86-28896 | NTIS, PC A02/MF A01 | | | 12:7546 |
| 86-28897 | NTIS, PC A03/MF A01 | | | 12:7547 |
| 86-28898 | NTIS, PC A02/MF A01 | | | 12:7548 |
| 86-28900 | NTIS, PC A04/MF A01 | | | 12:7549 |
| 86-28904 | NTIS, PC A$200.00/MF $200.00 | | | 12:7550 |
| 86-28905 | NTIS, PC A03/MF A01 | | | 12:7551 |
| 86-28997 | NTIS, PC A02/MF A01 | | | 12:6879 |
| 86-28999 | NTIS, PC A02/MF A01 | | | 12:6904 |
| 86-29007 | NTIS, PC A02/MF A01 | | | 12:6922 |
| 86-29024 | NTIS, PC A02/MF A01 | | | 12:6928 |
| 86-29148 | NTIS, PC A10/MF A01 | | | 12:6967 |
| 86-29156 | NTIS, PC A04/MF A01 | | | 12:7012 |
| 86-29301 | NTIS, PC A20/MF A01 | | | 12:7618 |
| 86-29409 | NTIS, PC A10/MF A01 | | | 12:6780 |
| 86-29412 | NTIS, PC A02/MF A01 | | | 12:6757 |
| 86-29420 | NTIS, PC A03/MF A01 | | | 12:6621 |
| 86-29744 | NTIS, PC A02/MF A01 | | | 12:7554 |
| 86-29745 | NTIS, PC A02/MF A01 | | | 12:7555 |
| 86-29756 | NTIS, PC A03/MF A01 | | | 12:7556 |
| 86-29908 | NTIS, PC A02/MF A01 | | | 12:6894 |
| 86-29959 | NTIS, PC A03/MF A01 | | | 12:6866 |
| 86-30095 | NTIS, PC A04/MF A01 | | | 12:7013 |
| 86-30099 | NTIS, PC A03/MF A01 | | | 12:7014 |
| 86-30136 | NTIS, PC A05/MF A01 | | | 12:6992 |
| 86-30160 | NTIS, PC A21/MF A01 | | | 12:6968 |
| 86-30272 | NTIS, PC A02/MF A01 | | | 12:7626 |
| 86-30380 | NTIS, PC A02/MF A01 | | | 12:7848 |
| 86-30425 | NTIS, PC A03/MF A01 | | | 12:7849 |
| 86-30485 | NTIS, PC A03/MF A01 | | | 12:7727 |
| 86-30517 | NTIS, PC A11/MF A01 | | | 12:6971 |
| 86-30518 | NTIS, PC A02/MF A01 | | | 12:6905 |
| 86-30554 | NTIS, PC A03/MF A01 | | | 12:6972 |
| 86-30555 | NTIS, PC A04/MF A01 | | | 12:6973 |
| 86-30610 | NTIS, PC A02/MF A01 | | | 12:7557 |
| 86-30611 | NTIS, PC A02/MF A01 | | | 12:7558 |
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| 86-30625 | NTIS, PC A03/MF A01 | | | 12:7561 |
| 86-30818 | NTIS, PC A10/MF A01 | | | 12:6867 |
| 86-30958 | NTIS, PC A10/MF A01 | | | 12:7016 |
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| 86-31031 | NTIS, PC A02/MF A01 | | | 12:7210 |
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| 86-31099 | NTIS, PC A06/MF A01 | | | 12:6597 |
| 86-31466 | NTIS, PC A11/MF A01 | | | 12:7563 |
| 86-31467 | NTIS, PC A04/MF A01 | | | 12:7564 |
| 86-31470 | NTIS, PC A06/MF A01 | | | 12:7565 |
| 86-31478 | NTIS, PC A02/MF A01 | | | 12:7566 |
| 86-31483 | NTIS, PC A$200.00/MF $200.00 | | | 12:7567 |
| 86-31522 | NTIS, PC A02/MF A01 | | | 12:7606 |
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| 1.15:87259 | *See* N-86-28125 | | | 12:6596 |
| 1.15:87293 | *See* N-86-28165 | | | 12:6829 |
| 1.15:87321 | *See* N-86-28776 | | | 12:7738 |
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| 1.15:88431 | *See* N-86-30518 | | | 12:6905 |
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| 1.15:88799 | *See* N-86-28378 | | | 12:6959 |
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| 1.26:4002 | *See* N-86-28445 | | | 12:6893 |
| 1.26:88386 | *See* N-86-28997 | | | 12:6879 |
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| 1.26:175108 | *See* N-86-28729 | | | 12:7222 |
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| 1.26:176854 | *See* N-86-31037 | | | 12:6929 |

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| 1.26:176875 | *See* N-86-31467 | | | 12:7564 |
| 1.26:176876 | *See* N-86-31466 | | | 12:7563 |
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| 1.26:177075 | *See* N-86-29148 | | | 12:6967 |
| 1.26:177090 | *See* N-86-30621 | | | 12:7559 |
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| 1.26:177143 | *See* N-86-30099 | | | 12:7014 |
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| 1.26:177152 | *See* N-86-31031 | | | 12:7210 |
| 1.26:177161 | *See* N-86-28196 | | | 12:6892 |
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| 177165 | *See* N-86-29409 | | | 12:6780 |
| 177166 | *See* N-86-28905 | | | 12:7551 |
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